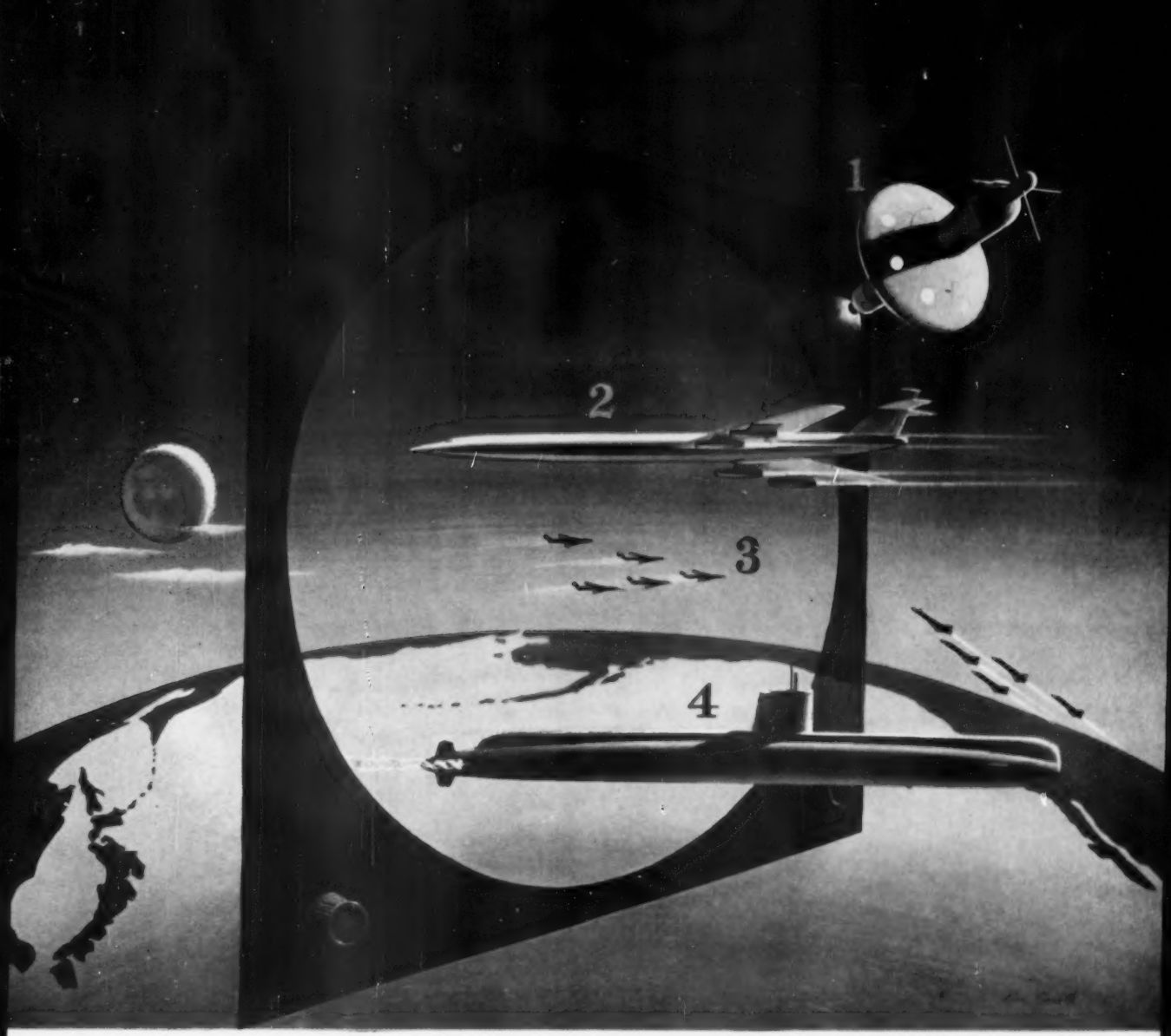
Aviation Week and Space Technology

October 17, 1960

Titanium Films Developed For Satellite Avionics

RAF Treble One Squadron
Bomb Burst at Farnborough



Marquardt/Pomona advanced simulation technique delivers increased information storage capacity

Now makes possible new inner/outer space applications.

A Marquardt conceived simulation technique that shrinks the map-scale factor 1:3,000,000—reducing the earth to a ball 14 feet in diameter—is now under development in the Pomona Division of The Marquardt Corporation. The advanced system has an information storage density potential of approximately 10^7 bits of information per square inch—an order of magnitude superior to any known storage method.

Immediate moving reference applications include:

1 SPACE NAVIGATION—Star pictures in relation to heliocentric coordinates and time can be stored.

2 TWO-DIMENSIONAL FLIGHT MAPS for low altitude guidance systems.

3 RADAR SIMULATION—Simulators for Radar Research, Satellite Radar, Flight Courses, and Airborne Radar.

4 SUBMARINE NAVIGATION—used as a supplementary navigational system, MIDSUN (Marquardt Information Data System for Underwater Navigation) stores underwater topographical and magnetic information as it relates to earth coordinates.

Other applications of the new Pomona system are in areas of large scale permanent data storage.

Detailed information on these and radar simulation training applications are available by writing Dr. Wendell B. Sell, Vice President-General Manager, The Marquardt Corporation, 2709 N. Garey Avenue, Pomona, California.

Engineers and scientists are invited to consult with this division in regard to their own career advancement.

POMONA DIVISION

THE Marquardt CORPORATION

2709 NO. GAREY AVENUE, POMONA, CALIFORNIA

ASTRO ◆ COOPER DEVELOPMENT DIVISION
◆ OGDEN DIVISION ◆ POMONA DIVISION
◆ POWER SYSTEMS GROUP

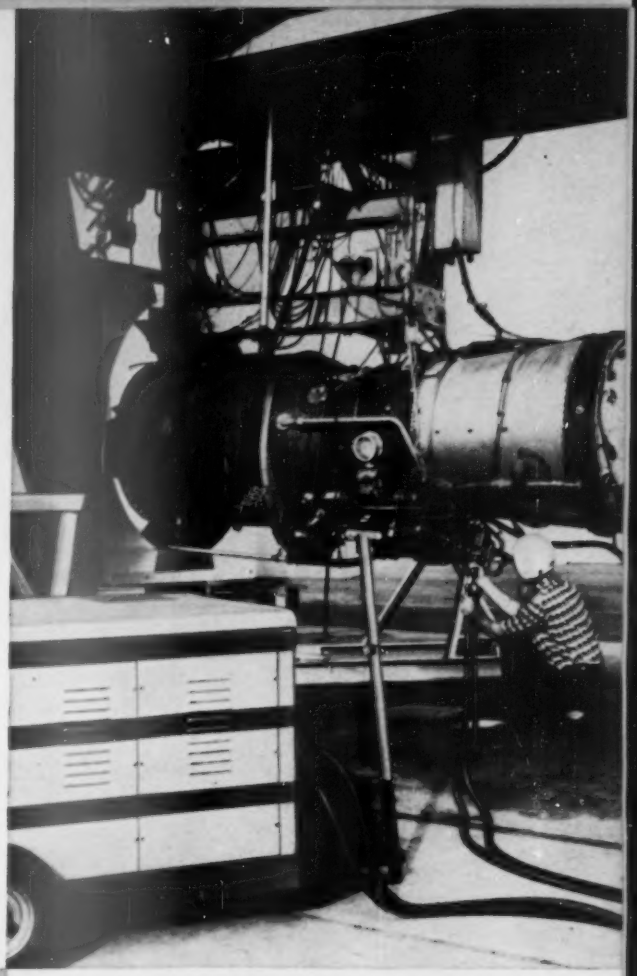
CORPORATE OFFICES: VAN NUYS, CALIFORNIA

CAPABILITY
is spelled
h-y-d-r-a-u-l-i-c
s-t-a-r-t-i-n-g

In technology and facility, Vickers continually matches your need

Auxiliary power units pioneered for aircraft turbine starting by Vickers combine high efficiency with minimum size and weight for the power delivered. Because starter characteristics are closely matched to engine requirements, they provide smooth, steady acceleration of the engine through the firepoint range giving the best possible chance of proper "lighting off" and avoiding aborted starts.

Dual-purpose units developed by Vickers as an outgrowth of pioneering work in hydraulic starting offer further benefits in weight saving. These units are used as a motor in engine starting, as a pump to supply accessory power during normal operation. Reduced cost and ground support requirements plus increased versatility and simpler remote area operation are other major benefits. Write for Bulletin A-6001.



PROVED PERFORMANCE of hydraulic starting for jet engines is demonstrated by this cart that has performed more than 2,500 trouble-free starts in a 2-year period. Cart size is due to divergent requirements of three different engines. Prime mover power requirement is only 25% of that needed for other starting methods due to inherent high efficiency of the hydraulic transmission.

JET PROP STARTING demonstration uses engine-mounted starter motor and ground cart power supply. Starter cutout speed of approximately 8,000 rpm was reached in 34.5 to 40 seconds during series of observed test starts.

MULTI-PURPOSE PUMP MOTOR (left) is pump when driving hydraulic starter becomes motor during normal flight to drive 15 KVA generator. **HELICOPTER STARTER** (right) is 35 hp unit, starts 1,900 shaft hp engine readily.

AERO HYDRAULICS DIVISION
VICKERS INCORPORATED
DETROIT 32, MICHIGAN
TORRANCE, CALIFORNIA

division of
SPERRY RAND
CORPORATION

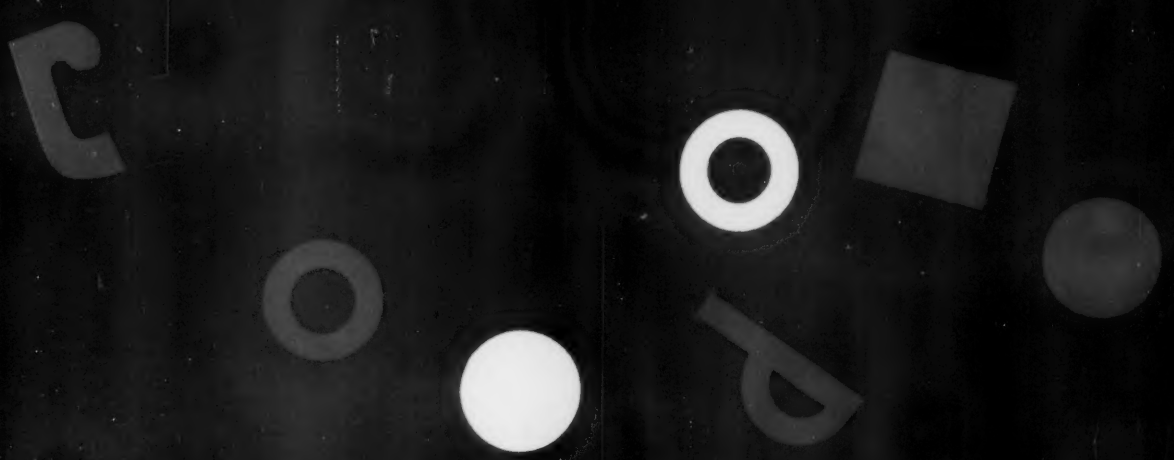
POWER TRANSMISSION
ENERGY CONVERSION
FLUID TRANSFER

8902

SILICONE NEWS from Dow Corning

SILASTIC LS
fluorosilicone rubber

is successfully solving design problems in sealing solvents, oils and fuels at temperatures from —100 to 350 F



Send for brochure detailing the benefits of Silastic® LS, the Dow Corning fluorosilicone rubber . . . Address Dept. 9

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

AVIATION CALENDAR

Oct. 24-25—Mid-Year Conference, Airport Operators Council, San Francisco, Calif.

Oct. 24-26—Medical and Biological Aspects of the Energies of Space, Unclassified Symposium, Granada Hotel, San Antonio, Tex. Sponsored by the School of Aviation Medicine. Arranged by Southwest Research Institute.

Oct. 24-26—Seventh East Coast Conference on Aeronautical and Navigational Electronics, Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.

Oct. 25-27—11th National Conference on Standards, Sheraton-Atlantic Hotel, N.Y.C.

Oct. 26-27—1960 Computer Applications Symposium, Armour Research Foundation of Illinois Institute of Technology, Morrison Hotel, Chicago, Ill.

Oct. 27-28—1960 Annual Electron Devices Meeting, Institute of Radio Engineers, Hotel Shoreham, Washington, D. C.

Oct. 27-29—1960 Industry Display, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Nov. 1-2—Fall Meeting, Radio Technical Commission for Aeronautics, Sheraton-Park Hotel, Washington, D. C.

Nov. 2-4—Tenth Aircraft Hydraulics Conference, Pick-Fort Shelby Hotel, Detroit, Mich., Sponsor: Vickers, Inc., division of Sperry Rand Corp. (Invitational.)

Nov. 3-4—Annual Fall Meeting, Northeast Chapter-American Assn. of Airport Executives, Sheraton Inn, Binghamton, N. Y.

Nov. 14-15—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Olympic Hotel, Seattle, Wash.

Nov. 14-16—National Convention, National Aeronautics Assn., Indio, Calif.

Nov. 14-17—Sixth Annual Conference on Magnetism and Magnetic Materials, New

(Continued on page 6)

AVIATION WEEK and Space Technology

October 17, 1960

Vol. 73, No. 16

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

Subscriptions are solicited only from persons who have a commercial or professional interest in aviation, including missiles and space technology. Position and company connection must be indicated on subscription order.

Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

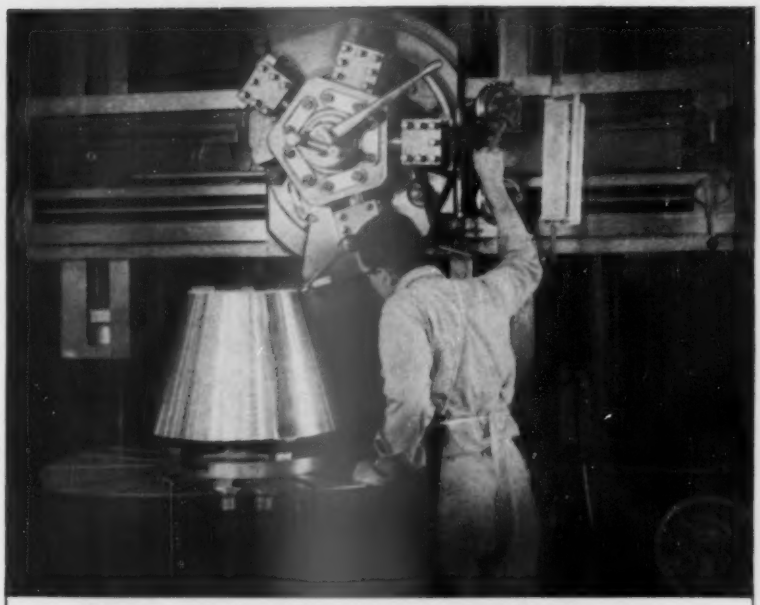
Any subscriber who is dissatisfied with this publication for any reason whatever, may cancel his subscription by writing our Fulfillment Manager. Refund for unexpired portion of subscription will be made promptly.

Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.

©Copyright 1960 by McGraw-Hill Publishing Co., Inc. **All rights reserved. Cable Address: "McGraw-Hill New York."** Publications combined with AVIATION WEEK and SPACE TECHNOLOGY are AVIATION, AVIATION NEWS, AIR TRANSPORT, AERONAUTICAL ENGINEERING and AIRCRAFT JOURNAL. All rights to these names are reserved by McGraw-Hill Publishing Co.

Subscribers: Send correspondence and change of address to Fulfillment Manager, Aviation Week, 330 West 42nd Street, New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, including postal zone number. Enclose recent address label if possible. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Fulfillment Manager, Aviation Week and Space Technology, 330 West 42nd Street, New York 36, N. Y.



missile | AEROSPACE COMPONENTS BY LAVELLE

Sheet metal wall thickness is controlled as the outer surface of an aluminum alloy nose cone is machined to precision size on a boring mill at Lavelle. Part of the RVX Series re-entry vehicle structure, recovered after full ICBM range flight, the machined cone is typical of methods used by Lavelle to meet the varied requirements of the aerospace industry.

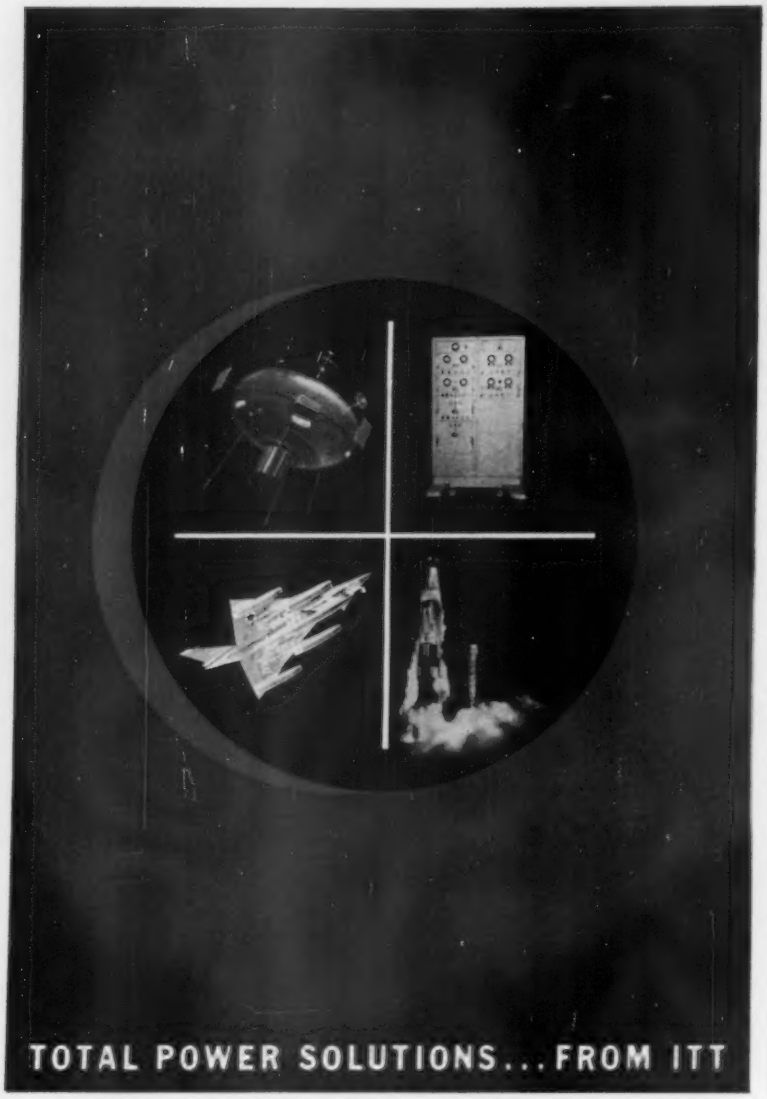
Shown between the nose cone structures above is a part of the Hawk missile system, a radar pedestal base magnesium weldment partially machined after assembly. Lavelle works with a wide range of metals and alloys to produce sheet metal components for missiles, electronic systems and ground support equipment to exacting specifications. Major companies rely on Lavelle for precision components required in missiles, space vehicles, jet engines and airframes.

If you would like to know more about Lavelle services, write for your copy of a new brochure describing our facilities.

Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.

Between Philadelphia, Pa., and Trenton, N.J.



Whether you're working with solar energy in space, ground test check-out equipment or anything in between... if your problem is power and the *environments are extreme,* ITT provides *compact, efficient* system solutions in the areas of

• CONVERSION • REGULATION • INVERSION • CONTROL

This total power capability has been proved in such customized designs as unique airborne multiple-output primary DC power supplies... complete power conversion packages for test vehicle check-out systems... aircraft missile launcher power supplies... and in many other weapons systems and space exploration projects.

To accomplish these *lightweight, ruggedized packages,* ITT takes your power problem at the design inception, carefully analyzes the load and draws upon a vast inventory of design and application data to develop fast, economical solutions.

ITT's total power capability is readily available to solve your toughest power problems. Contact your ITT Power representative or write for Data File AW-1284-2.

ITT
Industrial Products Division
International Telephone and Telegraph Corporation
15191 Bledsoe Street • San Fernando, Calif. • EMpire 7-6161
static power conversion • instruments • closed circuit television

AVIATION CALENDAR

(*Continued from page 5*)

Yorker Hotel, New York, N. Y. Sponsors: American Institute of Electrical Engineers; American Institute of Physics; Office of Naval Research; Institute of Radio Engineers; American Institute of Mechanical Engineers.

Nov. 14-18—Flight Safety Foundation's 13th Annual International Air Safety Seminar, in cooperation with Aviation Crash Injury Research, Phoenix, Ariz. For FSF members and by invitation.

Nov. 14-18—Western Engineering Conference and Exhibit, American Society of Tool and Manufacturing Engineers, Memorial Sports Arena, Los Angeles, Calif.

Nov. 14-19—Annual Convention, Air Line Pilots Assn., Carillon Hotel, Miami Beach, Fla.

Nov. 15-16—Symposium on Engineering Application of Probability and Random Function Theory, Purdue University, Lafayette, Ind.

Nov. 15-16—12th Annual Mid-America Electronics Conference, Institute of Radio Engineers, Hotel Muehlebach, Kansas City, Mo.

Nov. 15-17—36th Meeting, Aviation Distributors and Manufacturers Assn., Riviera Hotel, Palm Springs, Calif.

Nov. 15-17—Air Force-Navy-Industry Propulsion Systems Lubricants Conference (unclassified), Hilton Hotel, San Antonio, Tex. Cosponsors: ARDC's Wright Air Development Division; Southwest Research Institute.

Dec. 5-8—15th Annual Meeting and Astronautical Exposition, American Rocket Society, Shoreham Hotel, Washington, D. C.

Dec. 6-8—Annual Meeting, National Aviation Trades Assn., Oklahoma-Biltmore, Oklahoma City, Okla.

Dec. 13-15—Tenth Annual Eastern Joint Computer Conference, Hotel New Yorker and Manhattan Center, New York, N. Y. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; Assn. for Computing Machinery.

Dec. 17—24th Wright Brothers Lecture, Natural History Bldg., Smithsonian Institution, Washington, D. C.

Dec. 26-31—127th Meeting, American Association for the Advancement of Science, New York, N. Y.

Dec. 28-30—Seventh King Orange International Model Plane Meet, Miami, Fla.

Jan. 9-11—Seventh National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Philadelphia, Pa.

Jan. 9-13—International Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.

Jan. 16-18—Seventh Annual National Meeting, American Astronautical Society, Dallas, Tex.

Jan. 23-25—29th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 24.

Feb. 1-3—Second Winter Military Electronics Convention, Institute of Radio Engineers, Biltmore Hotel, Los Angeles, Calif.

Mar. 16-18—Fifth National Conference on Aviation Education, Mayflower Hotel, Washington, D. C.

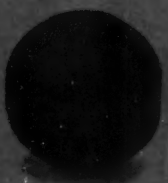
Hystran*
PRESSURE VESSELS

270% HIGHER $\frac{\text{STRENGTH}}{\text{WEIGHT}}$ THAN STEEL

Now available in production quantities!

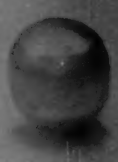
1300 cu. in. bottle for storage of high pressure nitrogen in ground-to-air missile. 8 ft. long, 5 in. dia., weight 32 lbs. including end fittings. 3000 psi operating pressure, 6000 psi proof, 9450 psi min. burst after proof and 30 operating cycles. Leakage guaranteed less than MIL-R-8573A.

Qualification test chamber designed to standard U.S. Navy specification. 18 in. diam., .041 wall thickness. 7.78 lbs. total weight including fittings and liner; 4.72 lbs. net weight of fiberglass-plastic. Tested to 650 psi burst, with hoop stress of 146,473 psi at burst. Actual strength-to-weight ratio of 2,035,000 in.



Spherical bottle for nitrogen storage in space satellite. 480 cu. in., 10 in. dia., 10 lbs. total weight. 3000 psi operating pressure, 5000 psi proof, 6667 psi min. burst after proof plus 25 operating cycles. Leakage guaranteed less than requirements of MIL-R-8573A.

2700 cu. in. bottle for nitrogen storage in space satellite. 2 ft. long, 13 in. dia., weight 31 lbs. including fittings. 3000 psi operating pressure, 3750 psi proof, 6000 psi min. burst after life of at least 400 operating cycles from 0 to 3000 psi. Leakage guaranteed less than MIL-R-8573A.



80 cu. in. bottle for storage of concentrated sulphuric acid. 5 in. dia., weight 1 lb. including Teflon liner wound into structure. 150 psi operating pressure, 300 psi proof, 750 psi min. burst. Minimum life of 1000 operating cycles from 0 to 150 psi. Leakage guaranteed less than MIL-R-8573A.

* This is Hystran, Lamtex's new space-age material that is solving high pressure storage vessel problems considered impossible or impractical with previously available materials such as aluminum, steel or titanium! A fiberglass reinforced plastic material, Hystran is filament-wound on automatic machines developed and built by Lamtex. The unretouched close-up photo shows the smooth finish and precise control of filament angles and spacing, resulting in a perfectly uniform, predetermined distribution of fiberglass and plastic, particularly when winding the calculated end shape. Equal tension control on each fiberglass filament is automatically maintained during winding, insuring against progressive fiberglass failure under high stresses.

In addition to the superior strength, weight and physical properties of Hystran, Lamtex's production-proved design and fabrication methods offer considerable savings in engineering time and tooling costs, plus a new degree of flexibility in the choice of sizes and shapes of pressure vessels. Standard procedures and production facilities are now available at Lamtex to handle—on a production basis, not prototype or experimental—filament winding of pressure vessels and other structural shapes up to 7 ft. dia. and 30 ft. long.

COMPARE THESE SPECS!

MATERIAL	DENSITY lbs/cu. in.	TENSILE STRENGTH psi	STRENGTH WEIGHT in. x 10^6
Aluminum	.097	80,000	.83
Titanium	.163	160,000	.98
Highly Heat Treated Steel	.283	240,000	.85
HYSTRAN	.072	165,000*	2.29

*Biaxially stressed hoop tension

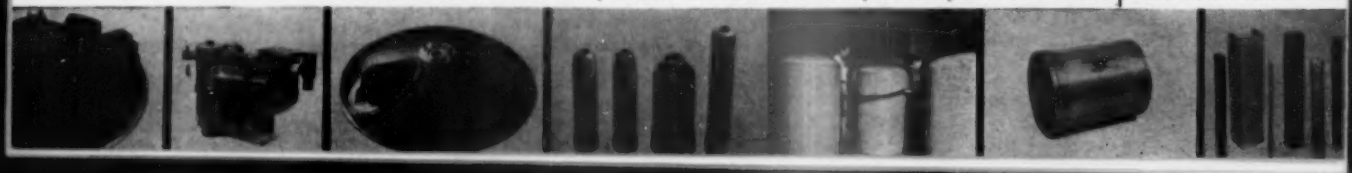
FOR COMPLETE DATA, SEND FOR BULLETIN 148

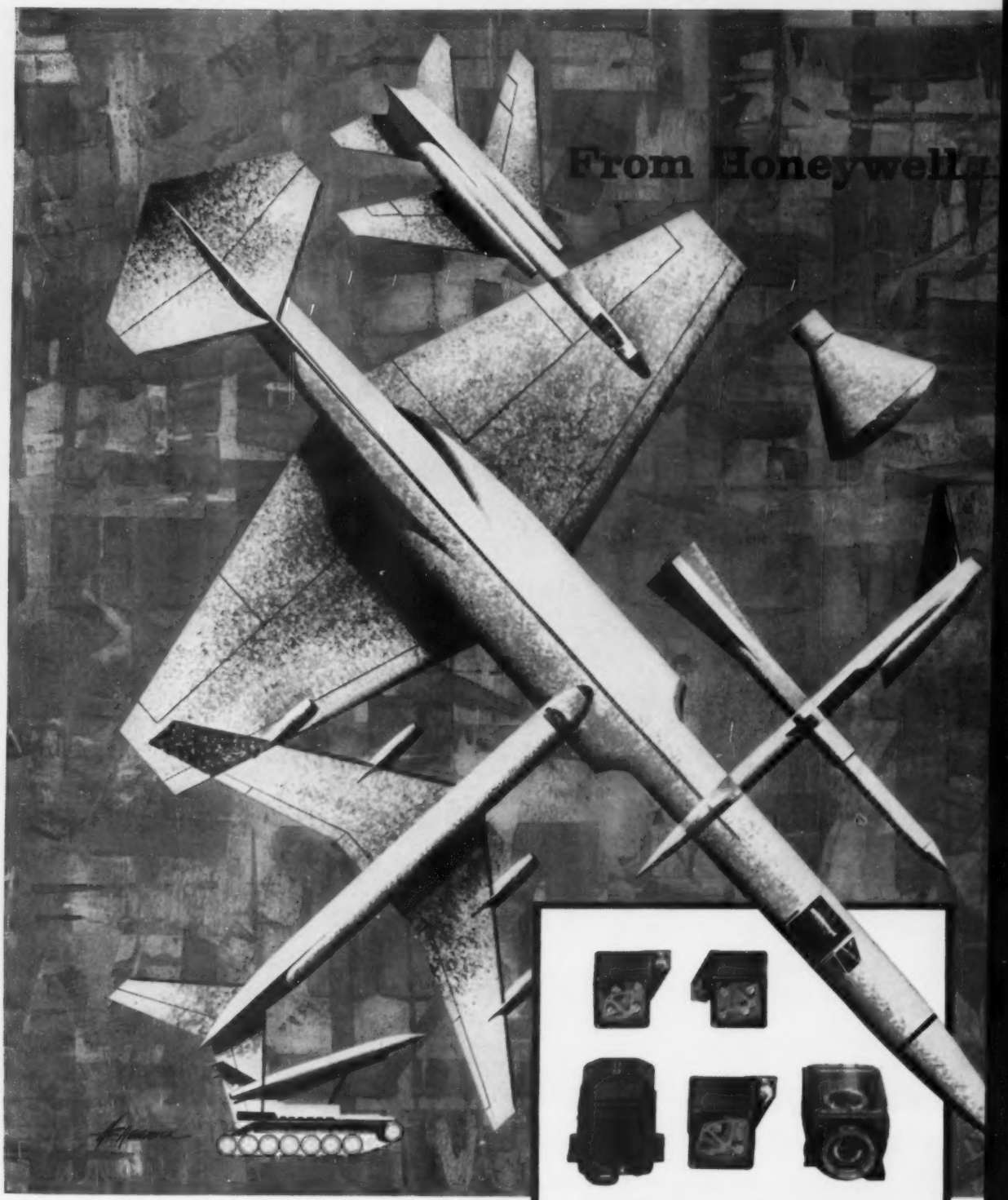
Advancing the State-Of-The-Art in Reinforced Plastics...

At Lamtex, it begins with R&D! The achievement of significant technological progress in the highly specialized, rapidly changing field of reinforced plastics depends largely on truly creative, "dig-down-deep" R&D. To obtain it, you must gather a staff of skilled specialists with outstanding records of past accomplishments and unlimited potential for future progress. Then give them the tools to work with, and the creative environment to work in—and you're well on your way toward advancing the state-of-the-art. This is what we've done and will continue to do. *Lamtex Industries, Inc., Motor Avenue, Farmingdale, L. I., N. Y.*

LAMTEX

HYSTRAN FILAMENT WINDING | CUSTOM MOLDING | FIBERGLASS-EPOXY TUBING | ROCKET MOTOR CASES & NOZZLES | RADOMES | MISSILE NOSE CONES | UNDERSEA VEHICLES





One of many different Honeywell Modular Gyro Reference Systems is shown at right. This all-attitude system is especially suited to high performance aircraft and provides pitch, roll and heading information for the automatic flight control systems, radar, gun sight, attitude indicator, magnetic compass readout, bombing computer and doppler navigation. Over 20 different gyro reference systems are available to meet all aircraft, missile, space vehicle and special purpose land vehicle requirements.

A New Modular Concept for Gyro Reference Systems

Honeywell offers you over 20 new Modular Gyro Reference Systems to meet virtually *all* aircraft, missile, space vehicle and special purpose land vehicle requirements.

This versatile new family of Gyro Reference Systems is created from standard, off-the-shelf components, to offer great flexibility, proven reliability—and, fast delivery. Accelerometers, repeaters and control panels combine to give you the widest selection of gyro reference systems available anywhere. This means that you can select the exact system to meet your requirements without waiting for or paying for a long development period. Extensive field and laboratory histories on each of these Honeywell reference system components assure system reliability.

Here's what Honeywell's new Modular Gyro Reference System Concept offers you:

- **Minimum delivery time**
- **Lowest possible cost**
- **Elimination of structural problems encountered when gyros are combined on a single platform**
- **Maximum flexibility and packagability**
- **Ease of maintenance (through modular makeup)**
- **Less volume required through easy utilization of irregular space**

Typical systems available provide: Standard Attitude, True Heading Attitude, All-Attitude and True Heading Attitude, Multiple Output All-Attitude, and Low Drift Azimuth All-Attitude. Many others are also offered. These systems are applicable to a wide variety of vehicles ranging from commercial and military transport aircraft, to heavy tactical aircraft, high performance aircraft, missiles, space probes, and special purpose land vehicles.

With this new Modular Gyro Reference System Concept, you can choose from the following features to meet your exact needs.

Ready time—1/10 second from inert storage

Accuracy—to 0.1°/hr. drift

Gyro weight—as low as 2.8 lbs. each

Erection—to computed local vertical without Schuler loop

Freedom—360° continuous—all axes

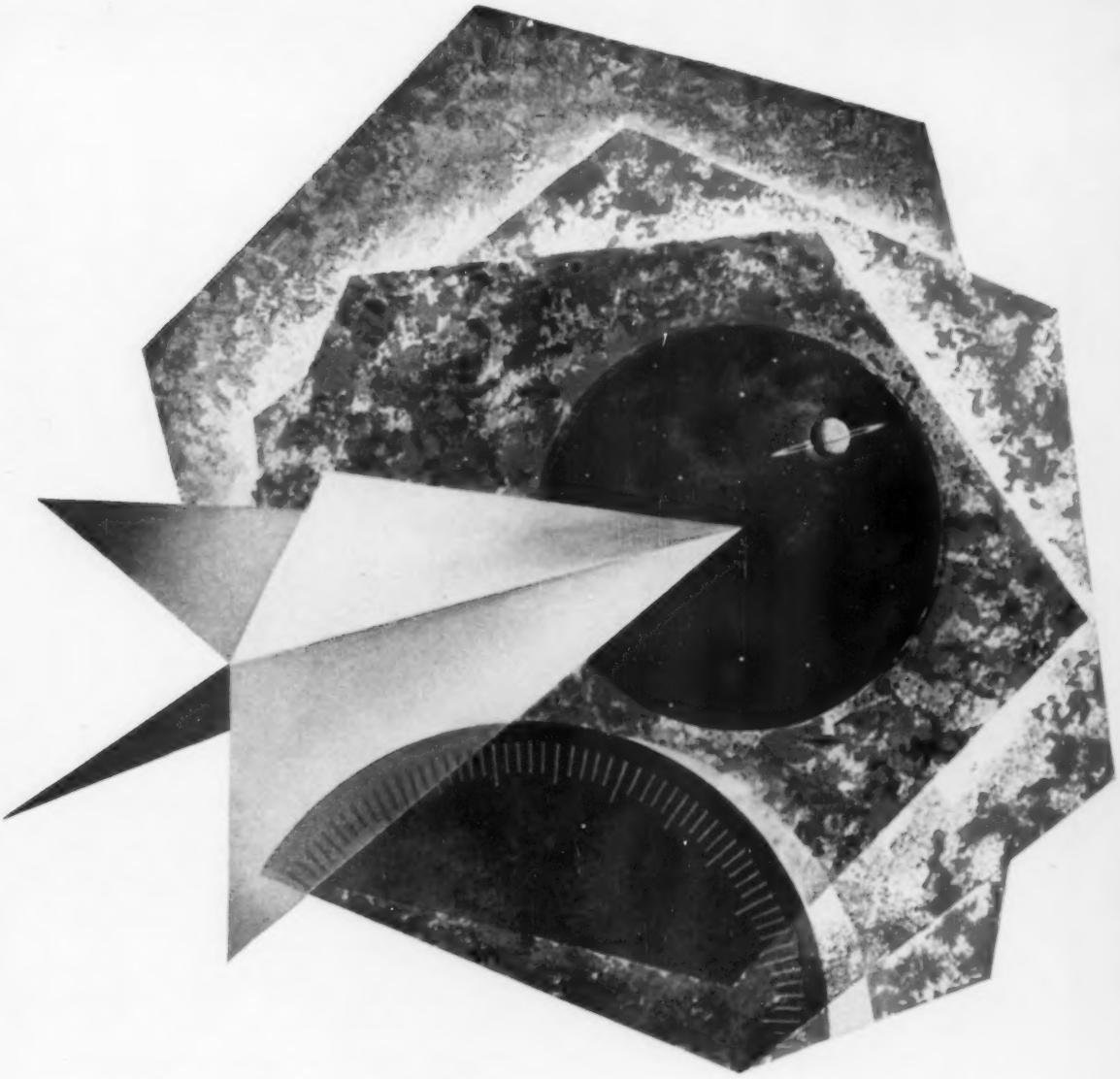
Acceleration—to 90 G sustained

To obtain a copy of Honeywell's new book, "Gyro Reference Systems," contact your Honeywell representative; or write: Honeywell, Aeronautical Division, Dept.AW-10-167, 2600 Ridgway Road, Minneapolis 40, Minnesota.

Honeywell

Military Products Group

Engineers and Scientists:
Explore the professional opportunities at Honeywell. See page 151



LIQUIDOMETER
instrumentation capability

. . . offers the dependability of long experience in both electronic and electromechanical instrument control systems, plus the versatility of original design.
If you are concerned with space vehicles, aircraft, ground support units, or test facilities—you are invited to investigate Liquidometer.
A new booklet outlining our capabilities is available on request.

THE LIQUIDOMETER CORP.
DEPT T, LONG ISLAND CITY 1, NEW YORK

Since 1920 --of proven quality

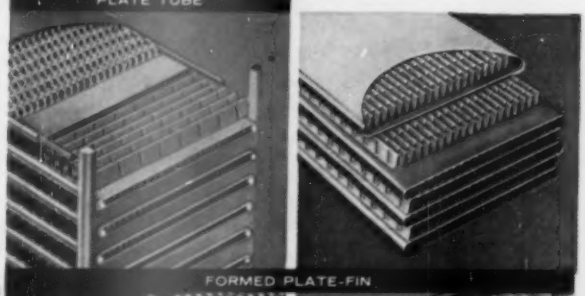
THERE'S A GM DESIGN TO KEEP EVERY TEMPERATURE IN LINE

Reliability is a reality at Harrison! And whatever your temperature-control problem, you can rely on Harrison's complete range of basic designs to give you the best possible selection for your particular job. This extensive coverage by Harrison is the result of over a half-century of experience in the design, engineering and manufacturing of top-quality heat control equipment. Save time and money. Call a Harrison Sales Engineer in at the design stage . . . and get the most reliable help with your temperature problem.

PLATE TUBE

HEAT EXCHANGERS UNLIMITED...

AIR COOLERS • WATER COOLERS GAS COOLERS • LIQUID METAL COOLERS • OIL COOLERS • AIR HEATERS • FUEL OIL HEATERS REGENERATORS • WASTE HEAT RECUPERATORS

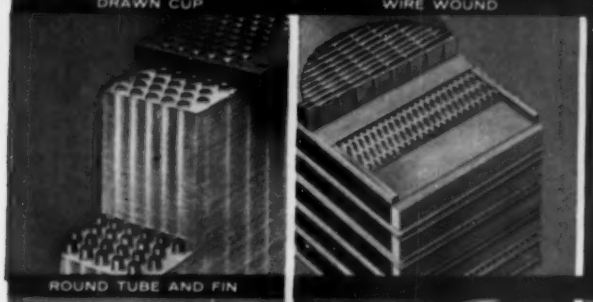

FORMED PLATE-FIN

DRAWN CUP

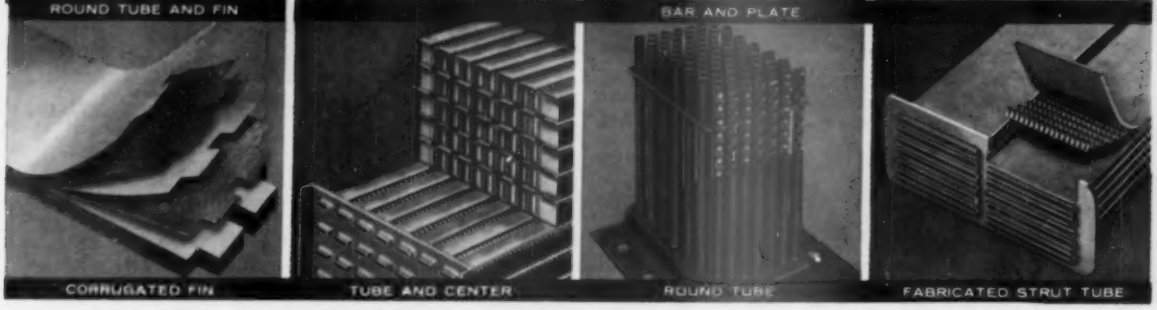
WIRE WOUND

DIMPLED STRUT TUBE

FLAT TUBE AND FIN


ROUND TUBE AND FIN

BAR AND PLATE


CORRUGATED FIN

TUBE AND CENTER

ROUND TUBE

FABRICATED STRUT TUBE

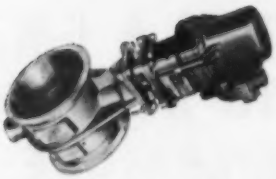
Free For an informative 48-page brochure on the complete Harrison line . . . write to Department 902

GM HARRISON

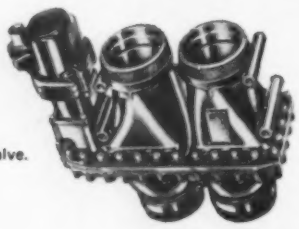
TEMPERATURES MADE TO ORDER

AIRCRAFT, AUTOMOTIVE, MARINE AND INDUSTRIAL HEAT EXCHANGERS

HARRISON RADIATOR DIVISION OF GENERAL MOTORS, LOCKPORT, NEW YORK

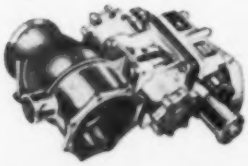


High pressure, high temperature butterfly valve.



Hot gas control valve.

Ice pre-sensing and control devices.



High temperature pressure regulator.

PRECISION PRODUCTS DIVISION

WG

WESTERN GEAR CORPORATION

WESTERN GEAR ENTERS VALVES, CONTROLS FIELD

by E. B. WORL
Sales Manager
Precision Products Division

Precision Products Division of Western Gear has aggressively entered the controls field and now makes available a complete line of electro-magnetic valves, hot air and gas valves, time and pressure switches, pressure regulators and related control equipment and specialized test equipment for application in missile, rocket and aircraft systems.

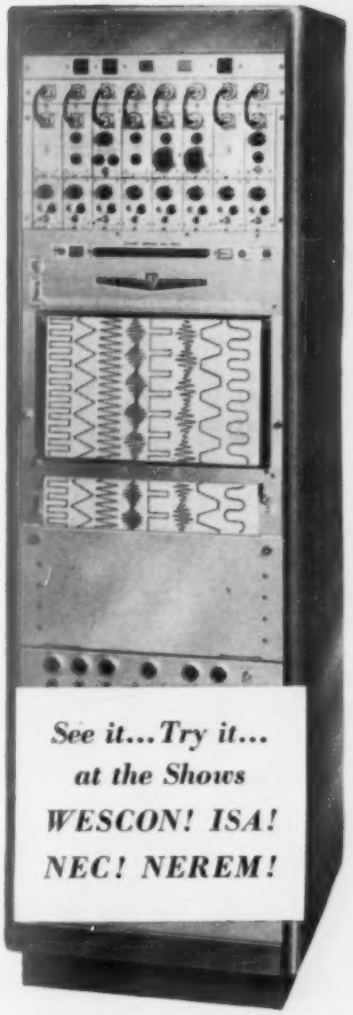
Precision Products Division will utilize designs and products of Teddington Aircraft Controls Ltd., recognized leader in the controls field throughout the world, under terms of a cooperative sales, service, engineering and manufacturing agreement.

Present applications include Rolls-Royce powered DC-8s, Boeing 707s, Fairchild F-27s, Caravelles, and numerous missiles.

Western Gear's Precision Products Division has long specialized in aircraft, rocket and missile components and systems as well as ground handling and test equipment.

For full information on Western Gear valves and controls, call or wire collect: Precision Products Division, P.O. Box 192, Lynwood, California; NEvada 6-0911.

Here's why the NEW AO TRACE-MASTER is the world's finest 8-channel direct writing recorder!



American Optical Company, famous for precision instrumentation for 138 years, introduces an electronic direct-writing recorder of unique design, in which ultra-precise electromechanics has been combined with advanced electronics to achieve *truly superior performance.*

Finest Writing Method Ever

Unique direct-carbon-transfer writing method. Trace is uniformly black and up to four times thinner than that made by any other recorder. Minute variations in phenomena measured are more faithful, meaningful. Carbon trace cannot fade... may be easily reproduced.

Finest Frequency-Amplitude Performance

TRACE-MASTER'S multiple-feedback wide-range Driver circuitry, combined with the advanced pen-motor design, produces wider frequency response *at larger amplitudes* than any other recorder. TRACE-MASTER response is flat—*within 1%*—from dc to 110 cps at 40 mm!

Band Amplitude Product (i.e. Bandwidth times Amplitude) is 5600...140 cps (3 db point) x 40mm!

Finest Chart-Drive Facilities

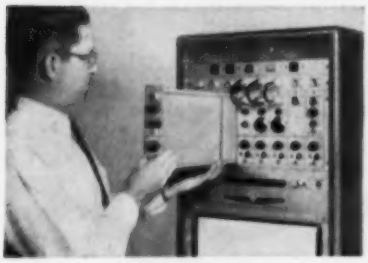
TRACE-MASTER provides widest chart-speed range...0.1 to 500 mm/sec...of any direct-writing recorder! Convenient push-button selection. Take-up reel automatically stores full 1000 ft. record. Writing table tilts for easy chart annotations. Guide rails permit quick, easy paper-roll changes. Low cost chart paper makes practical protracted recording at high speeds.

Finest Resolution, Linearity, Stability

Thin carbon trace (thinner by 4 to 1 over most recorders) and high Band Amplitude Product (higher by 6 to 1 over other recorders) provide up to 24 times the resolving power or ability to detect short, sharp variations in the record. The superior linearity (± 1%) and stability in rectilinear presentation permit full use of this unexcelled resolution.

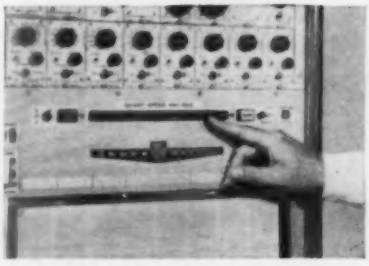
Finest Systems Oriented Computability

Fully transistorized circuitry...application of combined dc level and signal multiple feedback...complete interchangeability of modular signal-conditioning elements... are some of the features that make the AO TRACE-MASTER the world's finest 8-channel direct writing recorder.



Entire channel easily accessible and completely interchangeable as single unit.

Platen tilts to convenient writing angle.



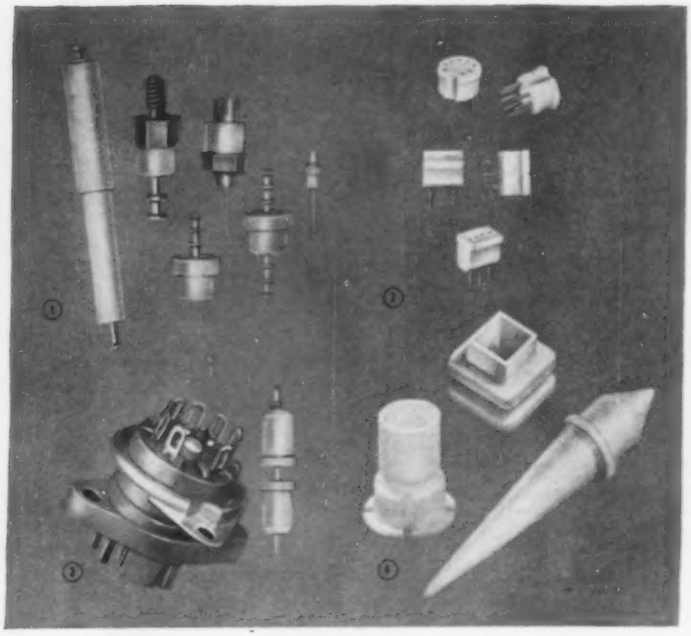
Widest range chart speed . . . push-button selection through 0.1 mm/sec to 500 mm/sec.

WRITE, WIRE, TELEPHONE TODAY FOR COMPLETE INFORMATION!

Complete Engineering Bulletins available.
Field Sales Engineers at your service everywhere.

American Optical
COMPANY
INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

ENGINEERED COMPONENTS
for the Electronic Industry



Garlock electronic components are skillfully engineered for high temperature, high voltage, high frequency service.

WHERE RELIABILITY IS CRITICAL

1. Chemelec* Stand-Off and Feed-Thru Insulators are easy to install, resistant to heat and breakage, and—above all—reliable under severest conditions . . . ideal for critical electronic circuits such as missile guidance, fire control, tracking, radar systems. Teflon**—due to its excellent dielectric, mechanical and th .rmal properties—is used as the insulator body. And, Chemelec Compression-Mounted Stand-Off and Feed Thru Insulators are designed for easy installation. You simply press them into pre-drilled holes; they become self-fastening, requiring no additional hardware or adjustment. Available in compression-mounted, metal-base, miniature and sub-miniature types . . . standard R.M.A. colors, a wide range of sizes and terminal designs.

2. Chemelec Sub-miniature Tube and Transistor Sockets have body insulating material of Teflon; contact material of brass, silver-plated and gold flashed. Capacitance pin to pin .6 MMF—pin to $\frac{1}{16}$" Chassis .7MMF. Chassis retention 50 lbs min. in $\frac{1}{16}$" panel. Contact retention 4 oz. per pin.

3. Chemelec Connectors are Teflon-insulated for outstanding high frequency service. Once installed, they require no further adjustment or hardware. .040, .050, .064 pin size, female also in .080 size.

4. Plastic Stock Shapes and Intricate Parts, inserts, thin sections, threaded parts to precision tolerances are available. Excellent facilities and experience in compression and injection molding, extruding, machining of Teflon, Nylon, Delrin**, Kel-F† or other industrial plastics.

Garlock facilities and personnel are at your disposal for design and development of new electronic products.

GARLOCK
ELECTRONIC PRODUCTS

Garlock maintains complete electrical, chemical, and physical laboratories staffed by top-flight research and development engineers.

Find out more about what Garlock offers. Contact the Garlock Electronic Products representative near you. Call him, or write for Catalog AD-169, Garlock Electronic Products, Garlock Inc., Camden 1, New Jersey.

*Registered Trademark **DuPont Trademark
†Trademark, Minnesota Mining & Manufacturing

The new Beechcraft L-23F . . .

Meeting the U. S. Army's requirement for a modern high-performance, low-cost transportation system

Already serving the U. S. Army, the versatile new Beechcraft L-23F is the latest in a long line of high-performance training and utility aircraft which Beech Aircraft Corporation has designed, developed and produced for the military services since 1932.

With supercharged fuel injection engines, the L-23F combines high altitude cruise power with exceptional short field performance, rugged durability and low operating costs to meet a wide range of needs . . . as a command liaison or personnel transport, a carrier of high-priority cargo, an aerial ambulance, or a multi-engine instrument trainer with a "big plane" feel. Designed and engineered for future pressurization and turbo-prop modification.

Beech Aerospace Division

BEECH AIRCRAFT CORPORATION • WICHITA 1, KANSAS.

Beech Aerospace Division projects include R&D on manned aircraft; missile target and reconnaissance systems; complete missile systems; electronic guidance systems; programs pertaining to liquid hydrogen propellants and cryogenic tankage systems; environmental testing of missile systems and components; and GSE. May we help you? Write, wire, or phone Contract Administrator, Beech Aircraft Corp., Wichita 1, Kansas—or nearest Area Office.

Valves and controls

AiResearch *has produced more than one million high performance valves and controls for gases and liquids operating at temperatures from −420°F. to +2000°F. and pressures to 6000 psig.*

Reliability and compatibility of systems applications are insured when *all* components are of AiResearch design and manufacture—backed by more than 20 years of experience in valves and controls and the most complete testing and production facilities available.

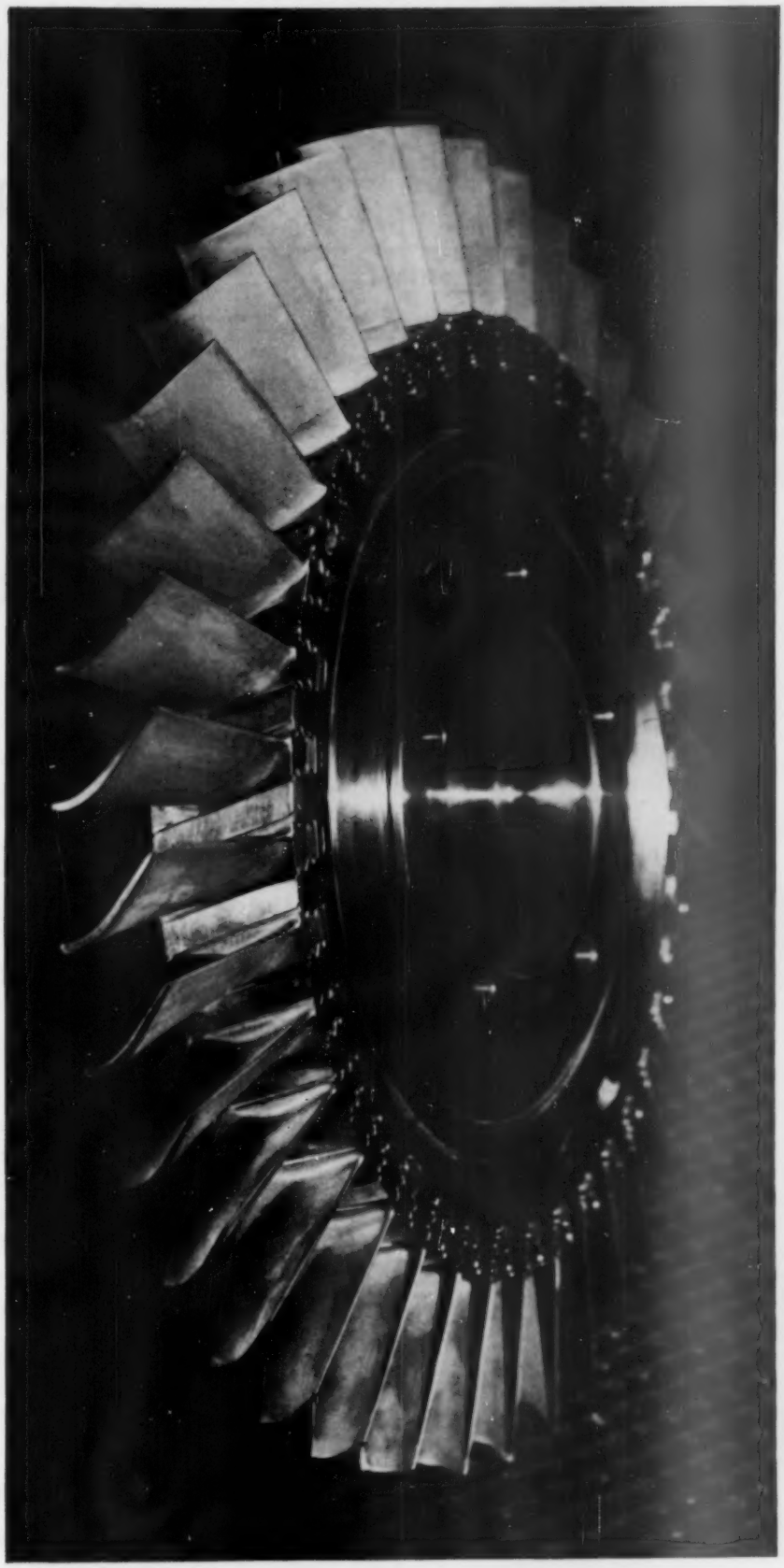
Please direct your inquiries to Control Systems, AiResearch Phoenix Division.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems and Components for: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS



complex jet engine componentry

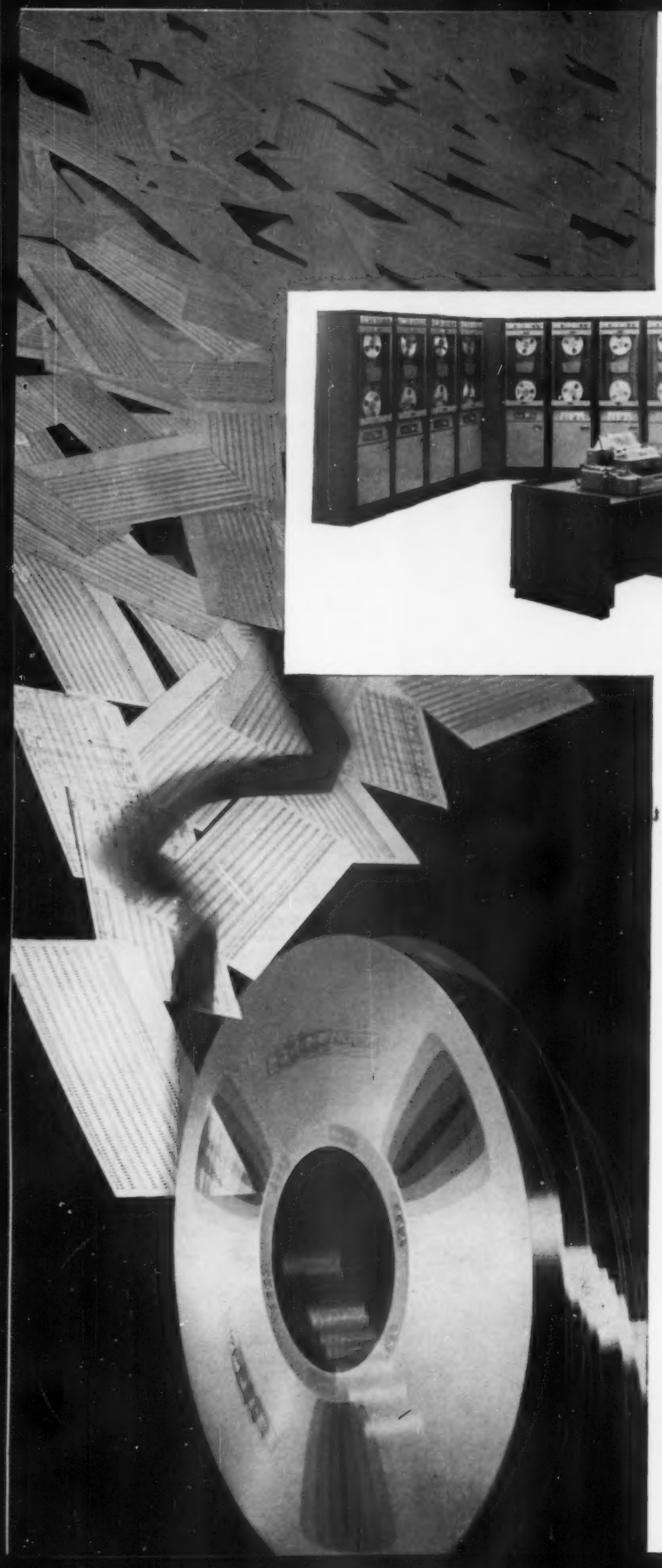
This complete jet turbine wheel is a product of Kelsey-Hayes, Jackson, Michigan plant. Its high standards of performance reflect Kelsey-Hayes' capabilities in the production of crucial rotating machinery, components and assemblies.

As a major subcontractor to the aerospace industries, Kelsey-Hayes' capabilities also include the production of vacuum-induction-melted alloys, as well as design, development and production of advanced thrust vectoring devices.
Kelsey-Hayes Company,
Detroit 32, Michigan.

KELSEY HAYES COMPANY

Automotive, Aviation and Agricultural Parts
Hand Tools for Industry and Home

18 PLANTS: Detroit and Jackson, Michigan; Los Angeles; Philadelphia and McKeesport, Pennsylvania; Springfield, Ohio; New Hartford and Utica, New York; Davenport, Iowa; Windsor, Ontario, Canada.



World's *fastest* sorting system

PHILCO 2000 Data Processing System

The majority of all data processing involves sorting. Time saved on this operation is always significant—the answers you need become available more quickly; the equipment itself is freed for other use.

The inherent speed and capacity of the Philco 2000 are your assurance of highest possible sorting speed—faster than any other sorting system! For example, *the Philco 2000 has sorted 100,000 80-character records, having a 16-character key, in 18 minutes!*

Such high sorting speed can be obtained on any Philco 2000, regardless of size, without additional sub-systems. One of the many programming aids provided by Philco is a powerful Sort Generator program.

Call or write to arrange a test run of one of your sort problems on the Philco 2000 Data Processing System.

Philco Corporation • Government and Industrial Group
Computer Division, 3900 Welsh Road, Willow Grove, Pa.

PHILCO®

Famous for Quality the World Over

October 17, 1960

Aviation Week and Space Technology

Vol. 73, No. 16
Member ABP and ABC

EDITORIAL OFFICES: New York 36—330 W. 42nd St., Phone: LOngacre 4-3000 (Nights LO 4-3035) Washington 4, D. C.—National Press Bldg., Phones: NAtional 8-3414, REpublic 7-6630 Los Angeles 17—1125 West Sixth St., Phone: HUntley 2-5450 Dallas 1—1712 Commerce St., Phone: Riverside 7-9721 European Office—1 rue du Temple, Geneva, Switzerland, Phone: 32-35-63

PUBLISHER.....Robert W. Martin, Jr.
EDITOR.....Robert B. Hotz

MANAGING EDITOR.....William Gregory
TECHNICAL EDITOR.....David A. Anderton
EUROPEAN EDITOR.....Cecil Brownlow

BUREAU CHIEFS
WASHINGTON.....Evert Clark
LOS ANGELES.....Irving Stone
DALLAS.....Erwin J. Bulban

DESK EDITORS.....Craig Lewis, John A. Nammack, Harry Raven
AVIONICS EDITOR.....Philip J. Klass
ASSISTANT.....Barry Miller
TRANSPORT EDITOR.....L. L. Doty
ASSISTANTS.Glenn Garrison, Robert H. Cook, David H. Hoffman, Jerome Bailey
ENGINEERING...Michael Yaffee, J. S. Butz, Jr., Russell Hawkes, William S. Reed
SPACE TECHNOLOGY....Edward H. Kolcum, George Alexander
MILITARY EDITOR.....Larry Booda
BUSINESS FLYING.....Erwin J. Bulban, Herbert J. Coleman
CONGRESS.....Ford Eastman, Katherine Johnsen
EQUIPMENT.....Barry Tully
ART EDITOR.....Lawrence J. Herb
ASST. ART EDITOR.....Karl G. Neuman
SPECIAL PROJECTS.....Andrew A. Keil
EDITORIAL PRODUCTION....Arnold Sherman
ASSISTANT EDITORS.....Elizabeth M. Hein, Edith Walford
EDITORIAL ASSISTANTS.....Marjorie Nail, Marjorie Todd
LIBRARIAN.....Theresa V. Maggio

FOREIGN NEWS SERVICE
EDITOR.....John Wilhelm
LONDON.....John Tunstall
PARIS.....Robert E. Farrell
MOSCOW.....Ernest Conine
MEXICO CITY.....Peter Weaver
TOKYO.....Sol Sanders

DOMESTIC NEWS BUREAUS
ATLANTA 3.....1301 Rhodes-Haverty Bldg.
CHICAGO 11.....520 No. Michigan Ave.
CLEVELAND 15...1164 Illuminating Building
DETROIT 26.....856 Penobscot Bldg.
HOUSTON 25.....W-724 Prudential Bldg.
SAN FRANCISCO 4.....68 Post St.

SALES
ADVERTISING SALES MANAGER
E. P. Blanchard, Jr.
ATLANTA.....R. H. Powell
BOSTON.....A. C. Boughton
CHICAGO and ST. LOUIS.....J. S. Costello, D. C. Jackman
CLEVELAND.....T. H. Hunter, Jr.
DALLAS.....R. T. Wood
DENVER.....John G. Patten
DETROIT.....R. R. Butera
LOS ANGELES.....C. F. McReynolds, D. T. Brennan, C. A. Ransdell
NEW YORK.....M. J. Storz, J. M. Grinton, R. Wallace, J. D. Warth
PHILADELPHIA..J. D. Willis, J. M. Tannehill
PITTSBURGH.....G. R. Schaefer
SAN FRANCISCO.....William Woolston
PROMOTION & RESEARCH MGR..C. C. Gersna
EUROPEAN MARKETING DIRECTOR
Fulvio Piovano
RESEARCH & MARKETING
Rosalie Christesen, Jacqueline Gonnet

BUSINESS
BUSINESS MANAGER.....J. G. Johnson
CIRCULATION MANAGER.....T. J. Lucey
ASST. BUSINESS MANAGER...W. V. Cockren
PRODUCTION MANAGER.....F. A. Dube

NASA Will Launch Commercial Satellites..... 26
▶Glennan offers booster, range, tracking at cost for industry-financed communications spacecraft.

Dutch Force Political Issue on Bilateral..... 38
▶U. S. ability to bargain strictly on economic basis questioned in KLM drive for route to Los Angeles.

Lockheed Develops Titanium Components..... 54
▶Chemical processes are used to fabricate thin films of titanium for high-reliability satellite components.

SPACE TECHNOLOGY
Communications Satellite System... 26
Commercial Satellite Proposals..... 26
Additional Samos Launches..... 28
Grumman Will Develop Spacecraft... 30
Improved Command Systems Urged.. 32
NASA Contracts..... 126
Space Vehicle Log..... 129

MISSILE ENGINEERING
Minuteman Case Construction..... 87

AERONAUTICAL ENGINEERING
Better Noise Research Urged..... 33
William Tell Meet..... 34
Short SC.1 Control System..... 78
Treble One Formation Team..... 148

AVIONICS
Titanium Components Developed.... 54
Space Vehicle Batteries Probed..... 63
Courier Ground Station..... 71
Filter Center..... 69
New Avionic Products..... 72

EQUIPMENT
Monitor Sets Climbout..... 92
X-15 Simulator..... 101
Jumps Prove Survival Concepts..... 105
Rotor Platform for Data Relay..... 113
Production Briefing..... 97
New Aviation Products..... 100

AIR TRANSPORT
Dutch Force Issue on Bilateral..... 38
Local Airlines on Mail Rates..... 39
IATA Agrees on Fixed Fares..... 40
TWA Finance Program..... 41
International Labor Meeting..... 41
Flight Engineer Strike Settled..... 42
Convair 880-M Flies..... 43
CSA Bids for Western Markets..... 45
Shortlines..... 52
Airline Observer..... 52

MANAGEMENT
Defense Tightens Foreign Spending.. 27
General Electric Strike..... 31
TSR. 2 Prototype Contract..... 34
Jets Swell U. S. Exports..... 132
Government Charged on Cargo Rates. 137
Who's Where..... 23
Industry Observer..... 23
Washington Roundup..... 25
News Digest..... 34
New Offerings..... 143

SAFETY
Soviet Report on Viscount Crash.... 34
Controversy Over Electra Crash..... 42
Sightseers Hamper Rescuers..... 42
Controllers Blamed in Crash..... 154

BUSINESS FLYING
Cessna Skyhook Helicopter..... 131
British Form Light Plane Group..... 27

Calendar..... 5
Letters..... 166

EDITORIAL
Nixon Takes a Stand..... 21

COVER: Spectacular bomb burst with Hunter Mark 6 fighters trailing smoke is finale to acrobatic display by Royal Air Force Treble One Squadron at annual flying display of the Society of British Aircraft Constructors at Farnborough. Note one Hunter whose smoke system has failed to function and another almost hidden in the other smoke trails. Farnborough performance was finale of four years of acrobatic work by Treble One in Hunters during which they pioneered full squadron strength maneuvers and devised many new acrobatic formations. For other pictures see p. 148.

PICTURE CREDITS

Cover—Ron Appelbe; 28, 29, 105, 107, 141—USAF; 30—Grumman, NASA; 32—Wide World; 43—Convair; 45, 47—Czechoslovak Airlines; 54, 55—Lockheed Missile and Space Division; 67—G. T. Schjeldahl Co.; 70—Lockheed Missile and Space Division; 71—U. S. Army; 76—Lockheed Electronics Co.; 78—English Electric; 79—Potez Air Fouga, Saab; 83, 132—Boeing Airplane Co.; 87—Allison Division; 89—Republic; 92—Safe Flight Instrument Corp.; 101, 102, 103—North American; 108—Max Holste; 113, 117—U. S. Industries; 122—B. F. Goodrich, Haynes Stellite Co.; 127—Avco; 131—Cessna; 135—Lockheed; 147—Beech; 148, 149, 150, 151—Ron Appelbe.

83,686 copies of this issue printed

SHORTER, SAFER STOPS FOR JETS WITH NEW BFG LIQUID-COOLED BRAKES

The revolutionary Liquid-cooled brakes developed by B.F.Goodrich have now been engineered for the Boeing 707-720. With completion of flight tests of the brakes on the 707 prototype, kits for equipping airline 707's for service testing and future certification are now being offered.

Tests show maximum temperatures at the brake lining surfaces are held below 500°F, compared to 2000°F in conventional brakes. With temperature and consequent lining wear greatly reduced, these advantages are realized:

• The aircraft can be stopped in minimum distances without ruinous brake damage. Several maximum-energy stops can be made without lining replacement. No restrictions on frequency of brake application are required.

• Aircraft availability is increased, as maintenance is reduced. In addition to the brake linings, life of seals and other brake components will be increased. Damage to brakes, tires, and landing gear from overheating is eliminated.

In the Liquid-cooled brake system, the heat of braking is absorbed by a circulating liquid which is passed through a heat exchanger to remove the heat. Surprisingly, over-all weight is no more than that of conventional brakes.

Liquid-cooled brakes, we believe, are the answer to the high energy braking requirements of large aircraft. Your B.F.Goodrich sales representative can give you further information. *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. AW-10C, Troy, Ohio.*

B.F.Goodrich aviation products

EDITORIAL

Nixon Takes a Stand

(Last week on this page we noted that both presidential candidates had been strangely silent on the major issue of national defense since both parties adopted strong planks on this issue at their conventions last summer. We urged both candidates to make their views on this vitally important subject clear to the voters before the Nov. 8 election. Last Tuesday and Wednesday Vice President Nixon tackled the defense issue in two speeches in California, one at San Diego and the other in Long Beach. Because of the importance of anything both candidates say on this subject we are presenting the main points raised by Mr. Nixon. To date Sen. Kennedy has said little on this issue and all press inquiries on the subject have been answered by ghost written statements from his headquarters culled from pre-campaign speeches and Senate debate.—Ed.)

Vice President Richard M. Nixon outlined a specific course of action for strengthening national defense and the civil aviation industry last week as he campaigned in California areas deeply concerned with these issues. He called for a more vigorous, more imaginative federal policy to help the aviation industry's transition into the jet age, and he advocated increased defense spending in various areas to ensure national survival.

This is how Nixon proposed to meet the problems in these areas:

- **Establish a special** presidential air policy commission to re-evaluate the U. S. aviation industry and recommend a permanent national aviation policy before the end of next year.
- **Possibly elevate** the present Federal Aviation Agency to Cabinet status, with broad powers over all government aviation policy except those involving procurement of combat aircraft.
- **Propose government** aid in the development process of moving into the era of true supersonic air transport operations since the industry cannot do this alone.
- **Proceed with "all deliberate speed"** with the development of the anti-missile missile system and be prepared at all times to exploit technological breakthroughs.
- **Continue development** of the manned bomber and fighter. "Until the new weapon systems have been proven and all the bugs, including those of operational suitability, are clearly gone, we must continue to keep the older weapons in a high state of readiness."
- **Preserve** the nation's small war capability.

"There must be no dollar sign on what we are willing to spend to keep America the strongest nation in the world," Nixon said in his speech at San Diego. "We must anticipate that our defense expenditures will go up rather than down in the period immediately ahead of us. We must be prepared at all times to exploit technological breakthroughs. We cannot rely exclusively on an existing weapon, as the last Administration relied on the manned bomber, when new weapons such as ICBMs threaten to make them obsolete. For example, the concept of the anti-missile missile must be pursued, in my opinion, with all deliberate speed."

Nixon warned against making the transition from one class of weapon to another precipitously. "Until the new weapon systems have been proven and all the bugs, including those of operational suitability, are clearly gone, we must continue to keep the older weapons in a high state of readiness," he said. "This means we cannot abandon development of the manned bomber and fighter because the missiles are dominating the technological advance."

"These insurances of survival which I have enumerated will be expensive and we must be prepared, if necessary, to pay more taxes to meet the bill," Nixon said. "At the same time, it is urgent that as we continue to build our military might we get a dollar's worth of defense for every dollar spent. We cannot tolerate duplication or allow petty inter-service rivalry to bleed our sinews of strength."

Discussing the problems of the aviation industry, the Vice President said "it is urgent, as we enter the sixties, that we are sure we have a healthy American aviation industry in all of its facets. We simply cannot allow our national pre-eminence in aviation, both commercial and military, to dissipate, nor can we allow the Communist system to outdo us in this area of great interest to all the world."

Nixon said the industry needs to be "freed from the traditional limitations of government policy." He proposed that a special air policy commission be established to re-evaluate the U. S. aviation industry's current pattern and problems and to recommend a permanent national aviation policy before the end of next year. This commission also would have the authority to work with the Defense Department on a re-evaluation of present policies governing military aircraft procurement.

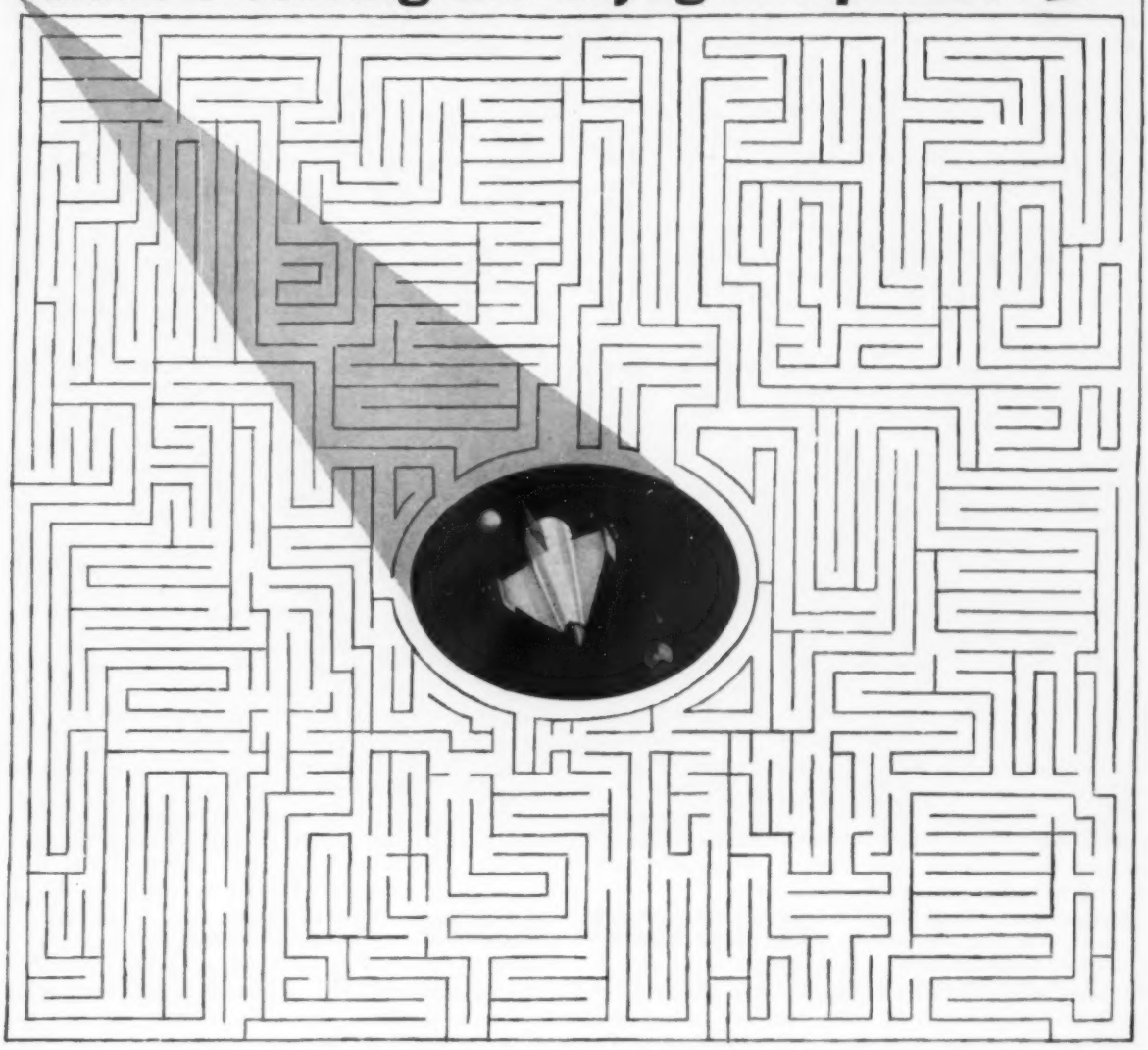
Civil aviation would get top-level government representation under Nixon's suggestion that "it may be time to elevate the present Federal Aviation Agency to Cabinet status with broad powers over all government aviation policy except those involving procurement of combat aircraft." This stand is based on the theory that federal aviation policy should be broadened beyond the confines of regulating public convenience and necessity and of safety and military considerations.

When he called for "more imaginative consideration" of national aviation policy, the Republican candidate observed that with the increasing emphasis on missile development, military aircraft development programs will no longer provide the impetus for advances in civil aircraft.

"We are leaving the sound barrier behind, and the development of our industry must keep pace," Nixon said. "As it now stands, the industry cannot do this alone. It must have government help in the development process. Nor can we longer rely on the accidents of military procurement to determine our civilian future in the air."

As the industry moves through the transition to the jet age and faces the problems of commercial supersonic flight, the Vice President said it is "harassed by the uncertainties of the situation and barely able to help itself, not only because of the staggering cost implications but because of the limitation of policies, good enough at the time, which must be revised and advanced so we may keep ahead in the 1960s."

Kidde's solving the Cryogenic puzzle!



How do you design cryogenic fuel power systems for space vehicles? Right now, Kidde is solving this problem for WADD of the Air Force.

Step by step, stage by stage, Kidde is defining and analyzing all factors . . . from tankage to secondary power to environmental and reaction control requirements. The result will be the solution to integration of all of these sub-systems into the optimized cryogenic power system for space vehicles.

Kidde's advanced cryogenic capability can solve your problems in this field. Put Kidde to work for *you*.

Kidde Aero-Space Division

Walter Kidde & Company, Inc., 1018 Main St., Belleville 9, New Jersey

District Sales Engineering Offices: Dallas, Texas • Dayton, Ohio • St. Louis, Mo. • San Diego, Calif. • Seattle, Wash. • Van Nuys, Calif. • Washington, D. C.
Walter Kidde-Pacific, Van Nuys, California • Walter Kidde & Company of Canada Ltd., Montreal, Toronto, Vancouver

WHO'S WHERE

In the Front Office

George M. Bunker, Clarence W. Miles, and **Maxwell B. Bassett,** directors of The Nuclear Corporation of America, New York, N. Y. Mr. Bunker is chief executive officer and board chairman of The Martin Co.; Mr. Miles is Martin's general counsel, and Mr. Bassett is head of Martin's corporate planning.

Fred T. Sonne, vice chairman of the board of Chicago Aerial Industries, Inc., Barrington, Ill. **Ernest G. Loeb** succeeds Mr. Sonne as president; **Marvin B. Ruffin** succeeds Mr. Loeb as executive vice president. Mr. Ruffin continues as general manager.

C. A. Chapman, vice president-sales, Lockheed Aircraft International, Los Angeles, Calif. Also: **C. A. Hoffiund,** vice president-operations, and **F. A. Kanzler,** treasurer.

Dr. Richard J. Burke, president, U. S. Systems Development Laboratory, Inc., Palo Alto, Calif., newly formed subsidiary of U. S. Systems, Inc.

John K. Rondou, president and general manager, Computer Measurements Co., Sylmar, Calif., a division of Pacific Industries.

Arthur L. Adamson, board chairman and chief financial officer, Electronic Associates, Inc., Long Branch, N. J., succeeding **Lloyd F. Christianson** who continues as president and chief executive officer.

Taft B. Russell, a director, Avionics Investing Corp., New York, N. Y. Mr. Russell is president of Applied Electronics Corporation of New Jersey.

M. L. Alson, vice president-sales, and **Francis Schmidt,** vice president-engineering, Brantly Helicopter Corp., Philadelphia, Pa.

Air Commodore F. R. Banks, managing director, Blackburn Engines, Ltd., Brough, England.

Norbert A. McKenna, New York investment banker, a director of California Eastern Aviation, Inc., Washington, D. C.

Dr. William J. Jacobi, vice president, Litton Systems, Inc., a subsidiary of Litton Industries, Beverly Hills, Calif., and general manager of the Guidance and Control Systems Division.

Col. William S. Evans, assistant director of information, Office of the Secretary of the Air Force. **Col. Richard K. Jacobson** replaces Col. Evans as director of information for the Air Research and Development Command. Also: **Col. Charles G. Mathison,** deputy director of information for ARDC.

Edward B. Sills, a vice president, Aviation Employees Corp., Washington, D. C.

Honors and Elections

William P. Lear, Sr., founder and board chairman of Lear, Inc., has received the City of Paris' Grande Medaille d'Argent (Great Silver Medal) as a tribute to his outstanding contribution towards the advancement of aviation.

William P. Gwinn, president and chief administrative officer of United Aircraft Corp., has been elected a director of the Transportation Association of America.

INDUSTRY OBSERVER

► Requests for proposals on shipborne equipment to be used with Navy's Transit navigation satellites are expected about the first of the year. Later this month, Bureau of Ships, Bureau of Weapons and Johns Hopkins University's Applied Physics Laboratory will brief industry representatives in Washington, D. C., on the Transit program's purpose and future.

► **Aerojet second stage engine for Minuteman has undergone preflight readiness test firings at the company's Sacramento, Calif., facility, and weight reduction objectives on the engine have been achieved a year ahead of schedule.**

► USAF hopes eventually to initiate experimental research and an engineering parametric analysis program for its Project Putt-Putt, formerly directed by Advanced Research Projects Agency under the name Project Orion. Putt-Putt is a feasibility study for development of a space vehicle propelled by controlled nuclear explosions (AW Feb. 29, p. 26).

► **NASA would prefer to have a second source for prototypes of most of the hardware it buys, choosing a prime contractor only after trying both prototypes, but expense so far has prohibited this.**

► Soviet helicopter designer I. P. Bratukhin is testing flying platforms equipped with four engines with horizontally rotating propellers located in circular openings at the four corners. Tests are being conducted at the Moscow Aviation Institute. Russians claim a large platform with an unspecified number of propellers of 6-ft. dia. can carry a load up to 40 tons for short distances.

► **Flight tests of the Convair Centaur second-stage rocket, powered by two Pratt & Whitney 15,000-lb. thrust liquid hydrogen engines, now are scheduled for the second quarter of next year. Stage carries four ullage rockets for stabilization and six verniers for attitude control. Engines are expected to permit two restarts on a single mission.**

► Russia's main Geophysical Laboratory is using a Mil Mi-1 helicopter equipped with an electrometeorograph to study the lower boundary layer of the atmosphere from 1.2 to 1.9 mi. altitude because standard aircraft, radiosondes and rockets have been unsatisfactory for this work.

► **Douglas S-IV stage for NASA's Saturn space vehicle will carry liquid hydrogen tank insulation on the inside wall rather than the outside, as does the Convair Centaur final stage.**

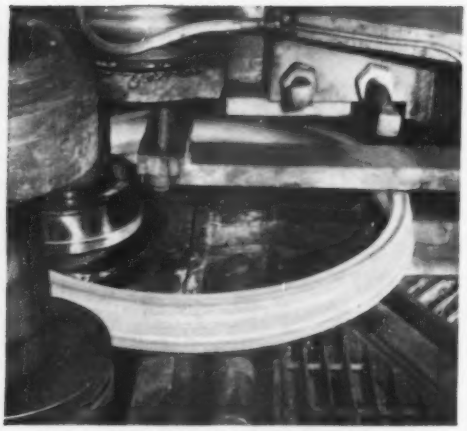
► USAF-Martin Titan G-8 ICBM went 6,000 mi. instead of the programed 10,000 mi. because a low-level sensor in the fuel tank incorrectly indicated at liftoff that it was uncovered. First-stage engine burned only 125 sec. instead of the scheduled 135. Missile carried about 1,250 lb. of extra instrumentation. Titan now has a record of 17 successes, three partial successes and four failures, counting the G-8 flight as a partial success.

► **Two new Russian vessels for oceanographic, hydrological and hydrobiological research are making test runs in the Baltic Sea.**

► NASA expects to ground-test electrical propulsion systems for space in 1962 and flight test them two years later. First system will have thrusts of .01, 0.1 and 0.5 lb.

► **Joint NASA-Italian program to launch sodium flare payloads in Nike Asp rockets (AW Aug. 29, p. 92) has been suspended at least for the remainder of this year because two launch attempts failed at Italy's Sardinia test site last month.**

► Safety precautions planned for use in launching of nuclear reactors or isotope power units into space include emergency escape rocket systems to catapult nuclear units clear of the pad in case of launch vehicle failure. Abort sensing systems similar to those used in the Mercury program would actuate the escape rockets.



Manufacturer uses ring-roller to shape turbine seal rings made of HASTELLOY alloy X

The surging power of modern 20,000-pound thrust jet engines is being harnessed effectively by critical parts made of HAYNES high-temperature alloys. Turbine seal areas are typical of the hot spots in which these alloys serve. Here, in the form of turbine seal rings, they contain the hot combustion gases as they roar through the various turbine stages.

In these, and in other parts too, such as afterburner liners, flame holders, shrouds, and investment-cast turbine blades and nozzle vanes, HAYNES alloys are resisting the punishing effects of long hours at high temperature. In fact, one of the Air Force's latest 1500-MPH jets uses six different HAYNES alloys in vital parts where heat and stress would weaken and fatigue other materials.

Whether investment- or sand-cast, rolled, wrought, vacuum melted, or air melted, there's a HAYNES high-temperature alloy to meet your needs.

HAYNES
ALLOYS

HAYNES STELLITE COMPANY
Division of Union Carbide Corporation
Kokomo, Indiana

Address inquiries to Haynes Stellite Company, 270 Park Avenue, New York 17, N.Y.

UNION CARBIDE

"Haynes," "Hastelloy," and "Union Carbide" are registered trade marks of Union Carbide Corporation.

Washington Roundup

Budget Review Begins

The services present their budget requests to the Defense Department this week. Initial review of the Fiscal 1962 requests will take the whole week. Basic requests call for a 10% increase over the present budget level to allow for inflation and increasing weapon complexity. The services also must submit versions at the Fiscal 1961 level, 5% above this level and 5% below it. In the past, the services submitted one budget at the previous year level and a second budget with no prescribed limit.

This trend to higher defense spending has been confirmed politically by both presidential candidates. Kennedy has long advocated increased spending, and Nixon made it clear last week in California that he expects military spending to increase (see p. 21). The lagging defense debate sharpened somewhat last week with the Vice President's remarks. But there has been little discussion so far on the recently increased Pentagon spending tempo.

Nixon is plugging the Quemoy-Matsu issue hard. (It worries U. S. strategists and it could obscure more important issues.) Officials who actually have to handle this Far East situation dislike seeing it become a hot issue, with the inevitable hardening of positions which they would rather leave as flexible as possible. It also makes relations extremely touchy with the Nationalist Chinese, who are sworn to defend the offshore islands.

Atomic Control Problem

Relatively cheap new West German method for producing fissionable uranium could vastly complicate the nuclear weapon control problem. This gas centrifuge system for enriching uranium would be inexpensive enough to put this atomic weapon material within the reach of many more nations than the four that have weapons now. This would mean that the U. S., Britain, France and the Soviet Union could no longer deal with nuclear control as an exclusive issue.

State Department is trying to head this situation off by convincing the Germans that some form of control should be imposed on the use of the new system. Consultations have been under way since July. The gas centrifuge system is still in the development stage, so there is still considerable time left to reach agreement.

A practical move toward nuclear test control has been taken with the completion of a prototype underground explosion detection station. Built under the uniform phase of Advanced Research Project Agency's Project Vela, this seismic station has 21 seismometers arranged in a pattern and sealed underground. It will be used to evaluate methods of detecting and identifying underground explosions.

The station is in an area chosen for its relative lack of routine seismic noise which would interfere with detection of disturbances over long distances. Called Wichita Mountains Seismological Laboratory, it is in southwest Oklahoma.

Bomb Display Dispute

State Department is backing AEC's refusal to permit display of replicas of the atomic bombs dropped on Hiroshima and Nagasaki. Their position is based chiefly on the potentially explosive emotional issue such a display could create in the Far East. AEC doesn't claim security or executive privilege in withholding the replicas—the agency just says it isn't in the national interest.

Rep. Charles O. Porter has been waging a fight with AEC for two years over this issue. Data on the weapons was declassified in 1958. Porter wants the replicas placed on public view in the Smithsonian Institution, where he feels they would have a beneficially sobering influence. Defense Department also would like them for some of their displays.

Details on the first two atomic bombs: Little Boy, dropped on Hiroshima, was a 10,000 lb. uranium bomb with a conventional type steel bomb casing 14 ft. long and five feet in diameter. Fat man, dropped on Nagasaki, was a finned 13,500 lb. tear-drop shaped plutonium bomb.

Senate committee launched an investigation last week into losses involved in cancellation of $2.1 billion in military research projects in the past three fiscal years. Sen. Hubert Humphrey is heading a Government Operations Subcommittee which will try to determine how much of the $2.1 billion was pure loss and how much produced knowledge valuable in other projects.

Investigation will cover contract termination reports and the index system used with them for filing information. Sen. Humphrey feels this aspect is a key to salvaging the data for use elsewhere.

—Washington Staff

Space Technology

NASA Will Launch Commercial Satellites

Glennan offers booster, range, tracking at cost for industry-financed communications spacecraft.

Washington—Intense commercial interest in communications satellites was further stimulated last week by the National Aeronautics and Space Administration's offer to launch and evaluate promising spacecraft developed and built by private industry.

NASA Administrator T. Keith Glennan said his agency will provide at cost the launch vehicles and range and tracking services for company-financed communications satellites which have a practical potential for commercial application.

Although Glennan set no limit on the number of proposals NASA can handle, cost of developing a complete system probably will result in a moderate number of proposals, principally from teams of several companies. Sponsors must bear the entire program development, launch and operating cost. One communications network plan by American Telephone & Telegraph Co. has an estimated cost of $165 million (AW July 18, p. 37).

NASA already has received a number of informal proposals from major communications firms as well as from companies not normally associated with the industry. With Glennan's offer—constituting a major government policy statement—competition among promising systems is certain to sharpen as firms vie to be first to be associated with the pioneer commercial space project.

Ultimate communications network may consist of several satellite systems, each owned by a different corporation.

The communications policy statement was not unexpected, since it follows the highly successful operation of NASA's passive Echo reflector satellite and the Army's active delayed repeater Courier IB, both of which are in daily experimental use. In addition, Glennan last month appointed Robert G. Nunn, Jr., as his special assistant to coordinate non-technical and non-military aspects of communications satellites.

In his new post (AW Sept. 26, p. 33), Nunn is initial contact for industry representatives with company proposals.

Glennan spoke last week to a state planning group meeting in Portland, Ore. He promised NASA will get out of the communications satellite program as soon as it is satisfied that industry is in a position to complete timely development of a commercial system.

Glennan said there is no reason to change the traditional U. S. policy of privately-financed communications carriers competing for business and operating under federal control to assure that the public interest is served.

Although communications are seen as the first non-government activity in space, Glennan cautioned that system developments are in their early stages, with considerable work to be done before reliable voice, telegraph and television links will be commercially feasible.

Unsolved Problems

Basic problems still unsolved are in the areas of component life, vehicle and spacecraft engineering, satellite types, system reliability, economics and negotiation of agreements with other countries.

Glennan said NASA is planning an "early flight" to demonstrate the feasibility of an active repeater satellite, and he emphasized this satellite will not duplicate programs under way.

NASA has funds only for the passive Echo reflector project in its current budget, but Glennan said the agency is preparing plans to develop a lightweight active repeater and launch it into a 3,000-5,600-mi. orbit. At the Goddard Space Flight Center-industry conference in August, NASA said it is monitoring and studying Defense Department active satellites to determine their potentials for civil communications.

NASA's active program, Glennan said, will be undertaken "with the aid of industrial contractors [to explore] the main technological approaches which do not overlap with military undertakings."

He explained that the security requirement of military communications does not permit duplication by private industrial developments aimed at the commercial market.

In a reference to the successes of Echo and Tiros launches, Glennan said recent worthwhile achievements have restored the respect of the U. S. and the world in this country's scientific leadership, which is based on a wide

Hughes Communications Satellite System

Culver City, Calif.—Hughes Aircraft Co. is organizing a joint venture with several other firms in an effort to place an active (repeater) commercial communications satellite system into space ahead of those companies which publicly discussed similar projects during the past few months, informed sources revealed here last week.

Hughes actually constructed a complete lightweight (less than 100 lb.) payload designed to be put into a 22,752 naut. mi. synchronous equatorial orbit by a Thor Delta booster.

Spokesmen for Hughes declined to discuss the report beyond referring queries to a sketchy article appearing in a recent issue of an internally circulated company newspaper. The article described technical highlights of the payload and indicated that the National Aeronautics and Space Administration is currently evaluating a Hughes proposal for a communications satellite system (AW Sept. 19, p. 23).

Cylindrical in shape, the payload is about 18-in. high, roughly 30-in. in diameter and its outer surface is covered with solar cells. Similar in general configuration to NASA's Tiros I, it has a directional S-band antenna mounted on one flat surface.

Communications gear consists of a transistorized UHF receiver and a 2.5 watt S-band traveling wave tube transmitter. Besides its primary function of relaying radio, teletype and TV signals from one ground terminal to another, the combination transmitter-receiver will also handle guidance signals during the launch phase while the transmitter will telemeter data back to earth and the receiver will double as a command receiver.

Ground stations are expected to contain high-power UHF transmitters and a low-noise S-band receiver employing a highly-sensitive liquid-nitrogen cooled parametric amplifier.

Satellite antenna directivity will be maintained by spin stabilization which simplifies the vernier orbital correction system. The latter need consist of only two gas jets for complete velocity and spin orientation control.

The payload is said to be light enough for future models stemming from the basic design concept to be capable of boost into orbit by the projected NASA Scout vehicle.

Synchronous orbit is achieved by means of a synchronous apogee controller which directs jets in the payload to reorient the spin axis and then to cancel velocity errors.

Mapping Lunar Surfaces

Pasadena, Calif.—Systems capable of photographic mapping of the moon to a resolution of 100 meters for the entire map, and perhaps to one meter (with nine to 10 meters acceptable) for selected areas, are being studied under three parallel feasibility contracts from National Aeronautics and Space Administration's Jet Propulsion Laboratory here.

Firms conducting the studies are Eastman Kodak, Fairchild Camera & Instrument and Radio Corp. of America's Astro Electronics Products Division.

If the program, known as Visual Observation Instrumentation Subsystem (VOIS) gets proper funding, JPL plans to mount the photographic equipment on a lunar orbiter, using an Atlas-Centaur as the launch vehicle.

range of true scientific exploration rather than on propaganda effect.

Glennan said the same guidelines will be used in the over-all NASA communications program, which will be accelerated but not as a crash effort. The program will not duplicate Courier and Advent or private projects, he said, but will be undertaken along a broad front to assure early use of an economically sound system.

Army Picks Six Teams To Study Field Missile

Washington—Army awarded $250,000 contracts to six industry teams last week for feasibility studies of a field Army ballistic missile defense system.

Army Rocket and Guided Missile Agency is program manager for the system, designed to detect and destroy tactical missiles of the Pershing type (AW Oct. 10, p. 27), and it coordinated the Army team which selected the study contractors from 17 study proposals submitted by 30 companies in a variety of team groupings.

Study contract teams are:

- **Convair-Pomona,** with Burroughs Great Valley Laboratory and Westinghouse Air Arm Division.
- **Hughes Aircraft Co.,** with North American Aviation, Aerojet-General Nucleonics and R. G. LeTourneau, Inc.
- **Martin-Orlando,** with the W. L. Maxson Co.
- **Sylvania,** with Aeronutronic Division of Ford Motor Co.
- **Raytheon,** with International Business Machines Corp., Dunlap and Associates, Avco Research & Advanced Development Division, Northrop Corp.
- **General Electric,** with Chrysler Corp.

Defense Tightens Foreign Spending

Washington—Defense Department has tightened its control of military funds spent outside the U.S. as part of the government's drive to reduce the imbalance in foreign payments that has resulted in a drain on gold reserves.

Directives have been issued which will shift spending to U.S. sources wherever practical. They cover supply and services support for U.S. military forces overseas and the Military Assistance Program, and they also affect business practices of base, post and Navy exchanges overseas.

Although the outward flow of gold has eased in recent weeks, it was apparently felt that a measure of flexible control on the extensive spending overseas by the military services and military-connected activities would be necessary to prevent future unfavorable payment balances.

Department of Defense funds account for $3 billion spent overseas, including $300 million for Military Assistance Program, $2.2 billion in military expenditures and $500 million for "classified projects." Other spending, principally by the exchanges, accounts for $250 million, and personal spending by military-connected personnel overseas amounts to $900 million.

At present, the value of imports exceeds the value of exports by a small amount, while spending of U.S. tourists abroad accounts for $2 billion.

In the procurement of supplies and services for U.S. forces' use and for delivery to friendly countries, Defense said that the policy is to favor U.S. sources of supply whenever possible without incurring additional costs and without overriding U.S. foreign policy and Military Assistance Program objectives.

Strongest of the policy directives was one which "eliminates any existing special arrangements designed to specifically favor foreign procurement." In post-World War II years, such arrangements were made to help the economic recovery of numerous countries. Now it is felt that these countries are economically self-sufficient and no longer need a high level of support.

Specifically, military assistance offshore buying is not authorized if it will result in:

- **Serious adverse effects** on the U.S. defense production base.
- **Unjustifiable costs** in comparison with procurement costs in the U.S., including transportation from the U.S. to recipient countries.
- **Delays in delivery** incompatible with the U.S. defense objectives.
- **Production offshore** when it would be detrimental to the security interests of the U.S.

Exemptions to the restrictions on purchase of supplies and services for U.S. military forces include purchases made in accordance with treaties and agreements, emergency purchases, purchases of $2,500 or less, perishable subsistence, personal or professional services and purchases approved by the Secretary of Defense.

Purchases and merchandising of military exchanges overseas must conform with the following steps to assure maximum sale of American merchandise:

- **Strict compliance** with regulations requiring labeling and segregated display for foreign merchandise.
- **Prominent display** of American merchandise and special warranty and servicing provisions which will make American goods more economical in the long run.
- **Avoidance of inferior** foreign-made imitations and substitutes.
- **Cooperation with** U.S. suppliers in meeting foreign competition.

British Car Builder Forms Plane Group

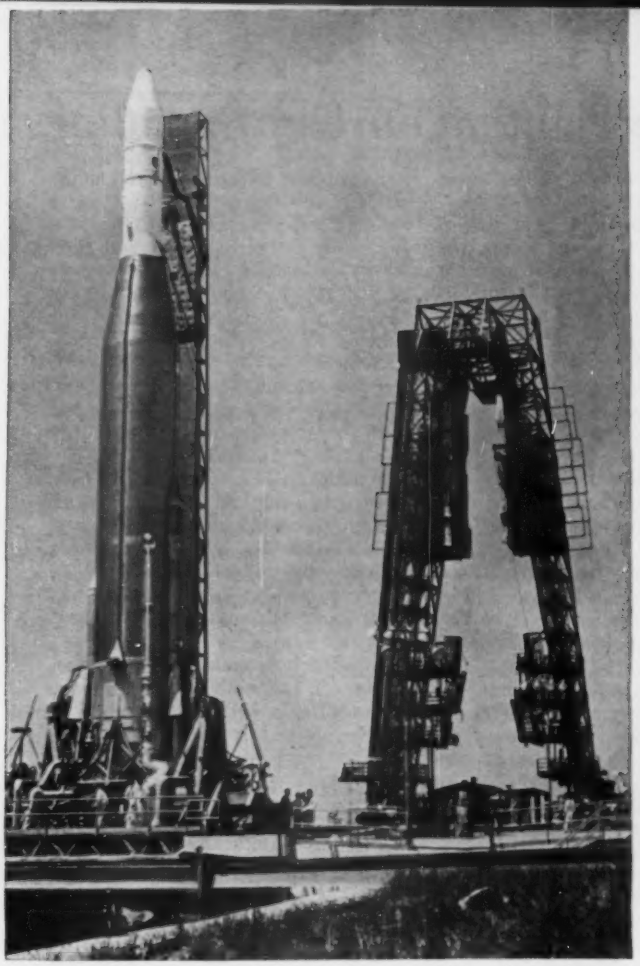
London—British light aircraft group has been formed by Pressed Steel Co., Cowley, considered the largest independent car body maker in Europe. The group, which will operate as a wholly-owned subsidiary, will be headed by Peter Masefield, former managing director of Bristol Aircraft, Ltd., with G. H. Miles as technical director. Both are light aircraft designers.

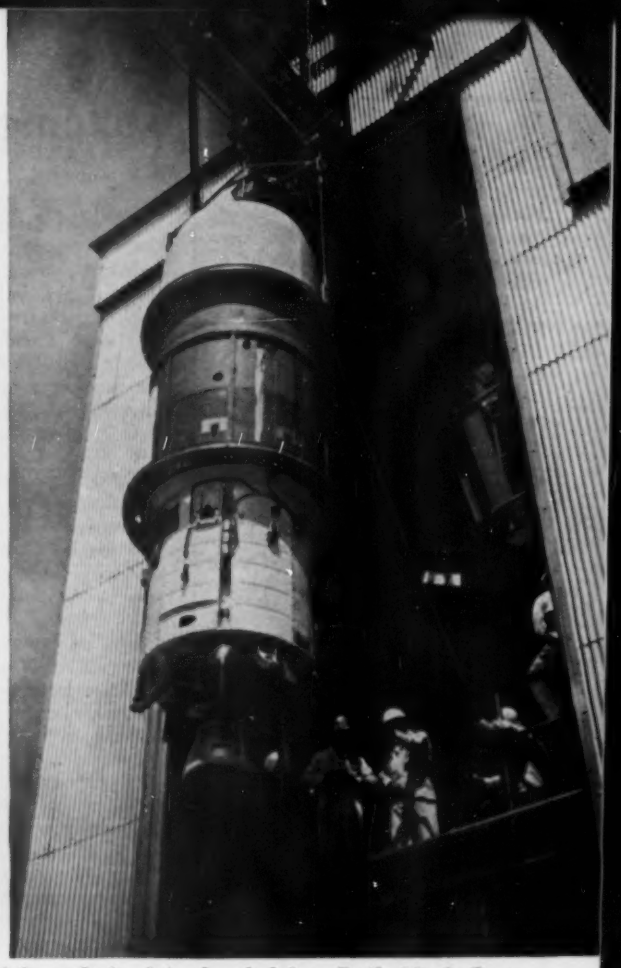
All issued capital of Auster Aircraft, valued at $1.5 million, has been acquired by Pressed Steel and will form the major part of the subsidiary named British Executive and General Aviation (BEAGLE).

In support of the group, technical and manufacturing liaison agreement has been made between the light aircraft company formerly managed by F. G. Miles, which carries his name, at Shoreham Airport. Rolls-Royce is negotiating with the group for development of a range of engines.

M. A. H. Bellhouse, deputy chairman of Pressed Steel and a wartime RAF wing commander, becomes chairman of BEAGLE. Managing director of Pressed Steel, J. R. Edwards, former production director of the British Motor Corp., has joined the BEAGLE board.

Besides becoming managing director of the new group, Masefield also assumes the chairmanship of Auster as well as becoming a board member of Pressed Steel. F. Bates, a founder of the Auster company, retains his position as managing director of Auster.





ATLAS booster is shown mated with an Agena satellite vehicle, designated Samos I after being launched from Pacific Missile Range, Pt. Arguello, Calif. The Agena A vehicle is hoisted into static test stand for rocket engine checkout at right.

U.S. Schedules Additional Samos Launches

By Irving Stone

Pt. Arguello, Calif.—Samos I, the United States' prototype experimental reconnaissance satellite was successfully launched from one of the two Air Force Atlas pads on the Navy's Pacific Missile Range facility here, but failed to be injected into its programed 300-mi.-high, near-circular, polar orbit after its second stage ignited to supply orbital speed. Follow-up launches tentatively are scheduled at two or three month intervals.

No capsule separation and recovery attempt had been programed for the Samos I experiment, although indications are that after a few follow-up Samos firings, recovery of photographic film within an ejected capsule probably will be attempted.

From a horizontal orbiting attitude, the Samos Agena-A orbiting vehicle was scheduled to be programed from the Kodiak, Alaska, tracking station to be gradually reoriented by rotation on its pitch axis to achieve a nose-down position for earth viewing. This scheme was first anticipated more than two years ago in an AVIATION WEEK analysis (AW June 23, 1958, p. 18).

Atlas launch vehicle for Samos I was approximately 77 ft. high, including the adapter section. Atlas launch weight was approximately 262,000 lb. Rocketdyne booster barrels supplied approximately 150,000 lb. thrust each, sustainer barrel about 60,000 lb. thrust.

Atlas launch vehicle was equipped with the General Electric-Burroughs radio-command guidance system, which detects position and rate, compares this data with predetermined trajectory projections for flight corrections.

Satellite vehicle, programed to be boosted into orbit by the Bell Agena-A 15,000-lb.-thrust propulsion system, is approximately 26 ft. long, with a diameter of about 5 ft. Launch weight was approximately 11,000 lb. and orbital weight after fuel exhaustion was scheduled to be about 4,100 lb.

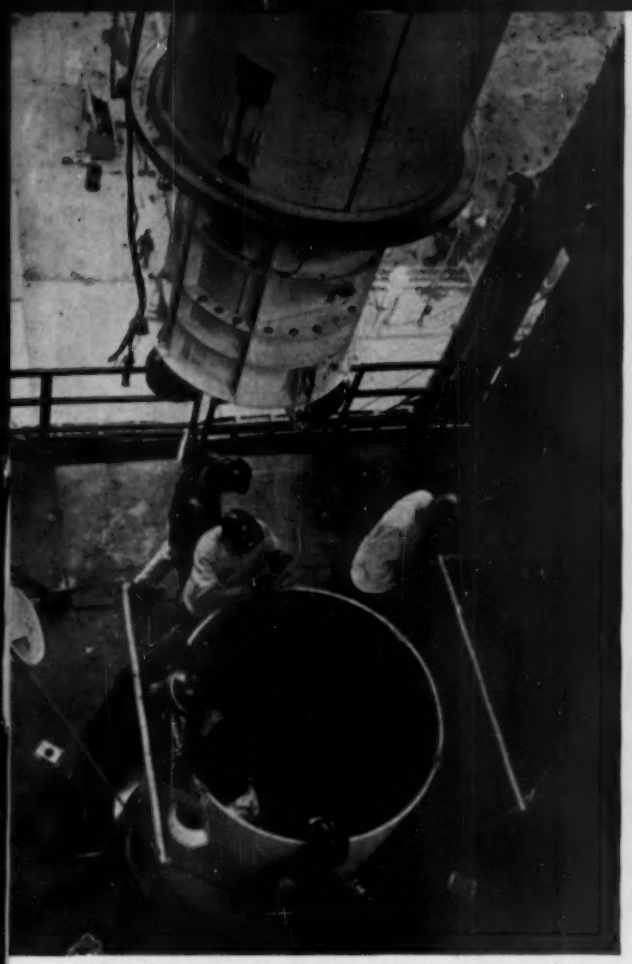
Following separation of the Agena-A stage from the Atlas launch vehicle, a coast period of approximately four minutes was initiated, during which the orbiting vehicle was scheduled to be oriented to its initial horizontal position. Following coast phase, the Agena-A was programed to burn for approximately two minutes to provide a speed of 17,050 mph. for injection of the vehicle into orbit approximately 1,730 mi. downrange from the Pt. Arguello launch site.

Time to orbit injection was scheduled to be approximately 10 min., and at the programed orbiting altitude of 300 mi., orbiting period was to be 94 min.

The experiment was significant for these reasons:

• **Samos I represents** the first U. S. attempt to put into space a military research and development system with a potential to photograph any part of the earth as it rotates within the satellite's north-south orbital passes, and return pictorial intelligence of selected viewing areas.

• **Organizational chain** for the Samos program specifically designates the Secretary of the Air Force in the key administrative-management slot. This unusual underscoring of top responsibility for a research and development project—probably the first time for an Air



TECHNICIANS around adapter section effect mating of Agena vehicle to Atlas booster. New satellite tracking and data acquisition station at Vandenberg AFB, Calif., covered Samos launch. Payload package consisted of photographic equipment and components.

Force secretary—stems from an order issued in September "for clear channels of command and decision," according to Air Force spokesmen.

From the USAF secretary, responsibility runs, for field extension, to the Air Research & Development Command Samos project office, draws engineering support from ARDC's Ballistic Missile Division and logistics support from Air Materiel Command's Ballistic Missile Center. Specific major areas of work management are delegated to Lockheed Missile and Space Division as prime contractor, Convair (Atlas booster), General Electric and Burroughs (booster stage guidance), Rocketdyne (Atlas engines), and Philco (ground-space communication equipment). Other Samos participants include Ramo-Wooldridge Division (data processing system) and its subcontractors, Eastman Kodak and Itek Corp. (optical equipment), Systems Laboratory Corp. (photogrammetry studies), and Servomechanisms, Inc., (data processing equipment manufacturing).

The program is aimed at establishing a valid scientific capability of reconnaissance from space above the atmosphere, as distinguished from Lockheed U-2 aircraft missions. This capability also has precedents in the purely scientific NASA meteorological Tiros satellite (AW Mar. 14, p. 26) and Explorer IV, (AW Aug. 17, 1959, p. 30) and in the Soviet lunar experiment (AW Oct. 12, 1959, p. 103) which returned photographs of the far side of the moon and which also could have returned pictures of the earth. Other Soviet experiments also may have had photographic capability.

Military managers of the Samos program are deliberately vague about revealing the initial orbiting vehicle's payload content, despite the project code name interpretation—Satellite and Missile Observation System. Specific photographic equipment, such as a camera and associated picture transmission components, has not been identified. Instrument package merely is described as "test photographic and related equipment," with initial Samos flights projected for "component testing to determine engineering feasibility of obtaining an observation capability from an orbiting satellite." However, Eastman Kodak optical equipment for the project has been available for almost a year, AVIATION WEEK has learned.

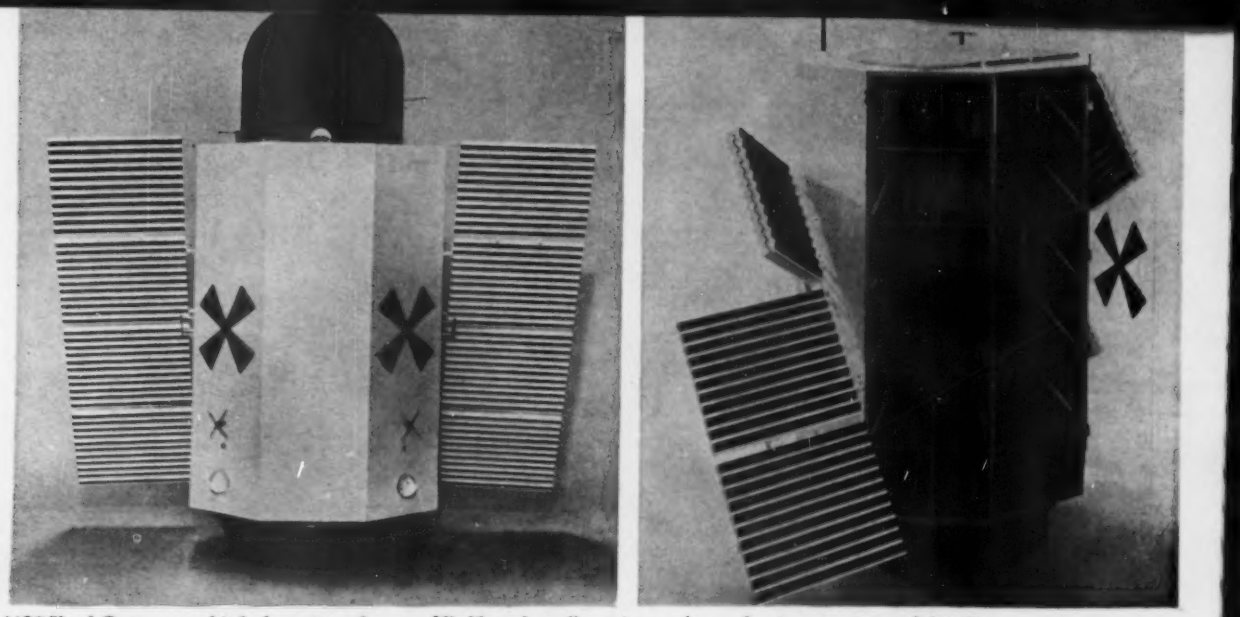
Considering the huge cost of a single Samos experiment—Convair Atlas-D booster, Lockheed's combination orbiting vehicle embodying the Bell Agena-A upper propulsion stage and instrumented forward compartment, associated launch facility expense and logistic support—it is likely that as much return as possible would be programed for the relatively short informational life (14 to 20 days) of the satellite.

Another indication of the completeness of the instrumented package is the 4,100-lb. weight of the orbiting Agena-A vehicle in the Samos experiment, compared with the 1,700 lb. for the orbiting Agena-A vehicle in the concurrent Discoverer program.

Atlas Mouse Flight

Cape Canaveral—USAF-Convair Atlas with three black mice riding in its General Electric RVX-2A nose cone was successfully fired along a high trajectory that carried it into the lower Van Allen radiation belt late last week. The nose cone was recovered near Ascension Island, 5,000 mi. downrange.

GE officials claimed the 2,800 lb. reentry vehicle is suitable for manned and unmanned flights in programs parallel to Discoverer, Samos and Mercury.



MODEL of Grumman orbital observatory shows paddle-like solar cells; cutaway shows aluminum-constructed interior.

Grumman Will Develop OAO Spacecraft

By Edward H. Kolcum

Washington—Grumman Aircraft Engineering Corp. entered the space business last week by winning a National Aeronautics and Space Administration contract to develop and build the basic 2,200 lb. spacecraft that will carry orbiting astronomical observatories (OAO).

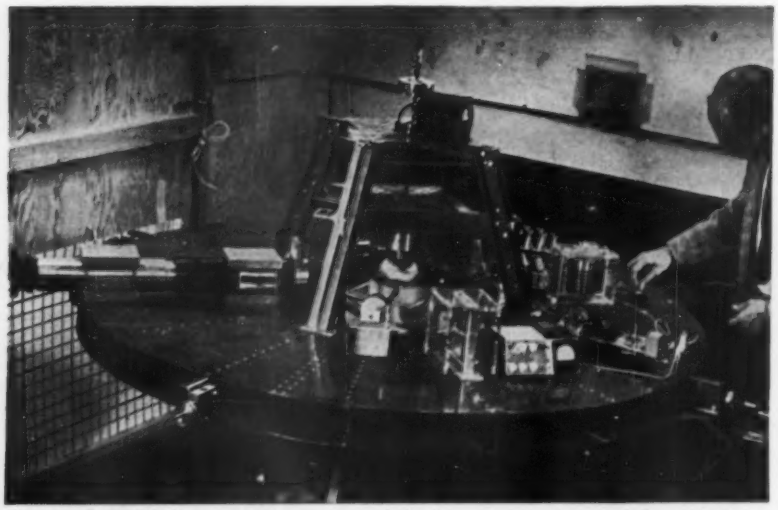
The spacecraft will be developed to house a variety of telescopes and spectrometers to permit stellar and ultraviolet observation unobscured by the earth's atmosphere. Instrumentation is being designed under separate contracts. Over-all OAO project is expected to cost more than $100 million.

OAO is the first space contract for Grumman, which was one of 11 companies submitting proposals. NASA is negotiating a contract, estimated at $23 million.

Contract calls for delivery of two spacecraft, the first in April, 1963. Launch with the Atlas Agena B is scheduled for late 1963 from Cape Canaveral. The Grumman-designed satellite will be launched into a 500-mi. circular orbit.

The observatory follows Ranger as the second NASA instrument carrier using the spacecraft concept, in which a standard shell is designed for more than one flight. Satellite and probe containers so far have been built around experiments essentially for single, specific flights.

OAO with instruments will weigh about 3,200 lb. It will be octagonal, 9½ ft. high and 6½ ft. in diameter. Key to operation will be precision pointing —within 0.1 sec. of arc—so that extended optical data on a single star can be obtained. NASA's Ames Research Center, conducting theoretical studies of system requirements, has examined several attitude control devices for a stable platform. Grumman proposal incorporates the reaction, or momentum, wheel for stability.



STABLE PLATFORM for orbiting astronomical observatory undergoes balance tests at NASA's Ames Research Center. Grumman Aircraft won $23 million NASA contract last week to develop 3,200-lb. spacecraft. Circular platform provides instrument table for star tracking telescope at the left. Platform is stabilized by inertia wheels.

OAO Experimenters

Experimenters already selected by NASA for OAO include Harvard University, Smithsonian Astrophysical Observatory, Princeton University, University of Wisconsin and Goddard Space Flight Center, which also is managing the project. Group developing instruments for solar experiments was at University of Michigan when the contract was awarded initially last year. When this group transferred to Harvard, the contract also was transferred.

Ames' work in attitude controls included construction of a full-scale prototype stable platform for experimentation with gyros, vapor jets and cold gas as well as with reaction wheels. The NASA center, which drew up the original system specifications, also is doing basic research on power systems, thermal balance and communications for OAO.

Experiments now being developed are:

• **Ultraviolet sky mapping**, by Smithsonian Observatory, in which system of

four or five telescopes will be coupled with television system to map the entire sky. Smithsonian estimates there are 10 million stars with a magnitude of 15 or brighter, which is the observation limit of the system. Optical system is under development at Smithsonian, and video image tube has been developed by Westinghouse Research Laboratory. Telescopes will have 8-in. reflectors and 20-in. focal lengths. Nebulae and newer stars are believed to have strong ultraviolet emissions, and comparison of these with older and colder stars is expected to contribute to a basic understanding of the formation of new stars.

• **Ultraviolet stellar spectrograph,** by Goddard, using a 36-in. reflector telescope to obtain spectral data on energy distributions of stars and ultraviolet emissions of nebulae. Special data will be stored for telemetry transmission rather than for video transmission as in the Smithsonian experiment.

• **Ultraviolet photometer,** by the University of Wisconsin, in which photocalls will be used to measure the intensity of ultraviolet emissions from gaseous nebulae.

• **High dispersion stellar** spectrograph, by Princeton University, using 24-in. reflector and spectrometer to investigate the dark, gaseous matter between the stars. The cosmic gas and dust will be observed against bright star backgrounds, and spectral data will be recorded by four photo tubes.

• **Solar experiments,** by Harvard, using three large grating spectrometers with small collecting mirrors. Objective is to observe the surface of the sun and solar atmosphere in order to analyze flares, sunspots, radiation and coronal regions. Videcon scanner will be coupled with the system for command transmission or storage.

A 500-mi. orbit is planned for the spacecraft because drag will be noticeable below 450 mi., and radiation shielding is necessary above 550-mi.

OAO will use the standard Minitrack network, with larger antennas to be installed at three stations for command and transmission. Ground signals will point and operate the satellite, and telemetry-video transmissions will be made from a wide-band system of over 100 kc. Narrow-band transmitter will transmit monitor information on the satellite environment.

Delayed Repeater

Delayed repeater will be used for readout when the satellite is over one of the three major ground stations. Specifications call for the satellite transmitter to have 2,500 mi. line-of-sight range. High power requirements of experiments and satellite equipment will be supplied with two solar cell paddle arrays, generating 350 watts. Power will be stored on nickel cadmium batteries.

Initial work on the astronomical satellite began in February, 1959, when astronomers met to discuss potential experiments. Preliminary specifications were sent to industry in August, 1958, and in December NASA conducted an industry briefing on the project. Request for proposals was issued in May, and proposals were due July 5.

NASA management team consists of Dr. Nancy Roman, NASA astronomy program chief; Robert Ziemer, project manager, and Dr. James Kupperian, project scientist. Ziemer and Kupperian are at Goddard.

SBAC Policy

London—Prospects for increased internationalization of the 1961 flying display of the Society of British Aircraft Constructors appeared dim last week after a post-mortem survey of the 1960 Farnborough show.

Earlier indications that foreign aircraft might be allowed in the SBAC display if they used major British components failed to materialize as the society began planning for the next year's display. Strong influence of the component manufacturers who now dominate the show with their static exhibits was exerted against any change in the traditional format. This policy was also supported by the two major aircraft combines but strongly opposed by engine manufacturers.

Budd Wins S-6 Contract

Washington—Budd Co. won a $159,894 contract last week to design and build the container for National Aeronautics and Space Administration's S-6 atmospheric structures satellite.

The 35-in. diameter sphere, which is Budd Co.'s first space contract, will carry instruments to measure temperatures, pressures and densities in a Delta-launched, 680-mi. orbit, launched by a Delta vehicle. Structure will be built of Type 304 non-magnetic stainless steel, .025 in. thick. Payload will weigh 369 lb. and is scheduled for launch in Fiscal 1962.

Mediation Continues In GE-IUE Strike

Washington—Strike against General Electric by International Union of Electrical Workers (IUE) appeared no nearer settlement late last week, despite continuing efforts of federal mediators and "truce offers" by both parties which were promptly rejected.

The IUE offered to suspend the strike (AW Oct. 10, p. 28) for one month if GE would agree to improve its original offer during the truce period. The company refused and offered to continue operations under former contract terms, except for future cost-of-living escalator clause, which the IUE promptly rejected.

Meanwhile, the company has asked for court injunctions at Schenectady and Syracuse, N. Y. and at Pittsfield and Lynn, Mass. plants to restrain union from mass picketing. Picket-line violence was reported at some plants when white collar employes and some production workers attempted to gain entry.

A modest increase was reported in the number of production workers at several major facilities. At the electronics Division plant in Syracuse, 1,245 factory workers reported on Tuesday, an increase of about 100 over the previous day, representing about 25% of the factory force. More than 800 factory workers reported at Pittsfield Tuesday, an increase of about 45 over the previous day. But at Lynn and Ft. Wayne, Ind. plants, fewer than 100 factory employes were at work.

In New York, GE filed a charge of unfair labor practices against the IUE, accusing the union of refusing to bargain in good faith with company-designated labor negotiators. The union was expected to strongly contest the charge. IUE President James B. Carey earlier had asked that higher-level company officials enter into discussions, but GE declined, stating that its negotiators have full authority.

The IUE was negotiating last week with Westinghouse Electric for modification of its contract, which was scheduled to expire Oct. 15. Most observers doubted whether union would strike at Westinghouse in view of its situation at GE and the fact that it had a long strike against Westinghouse five years ago. On the other hand, observers point out that Carey might find it difficult to settle with Westinghouse on terms comparable to those rejected at GE.

Late in the week, production and maintenance workers at Westinghouse's Motor and Control Division in Buffalo, which is the third largest division in the Westinghouse system, voted in favor of a strike.

Staff Change

New York—Cecil Brownlow has replaced David A. Anderton as European editor of Aviation Week with headquarters in Geneva. Anderton, who recently completed a three year tour as European editor, returned to New York where he is technical editor of the magazine. Brownlow was formerly Aviation Week's Washington bureau chief.

Improved USAF Command Systems Urged

Bedford, Mass.—Decisive action is required to coordinate the development and design of command and control systems if Air Force commanders are to control their aerospace forces effectively in the event of war, according to Air Force's Winter Study Group.

This is one of the most important conclusions of a recent report by the 139-man Winter Study Group, formed nearly a year ago to study Air Force command and control system needs in the coming decade and evaluate current efforts aimed at those needs (AW Oct. 3, p. 38).

Highlights of the report were presented last week to Air Research and Development Command Headquarters and soon will be presented to the Air Staff.

Unless efforts are made to integrate some of the command systems now under development or planned, the Air Force faces the prospect of a $10-15 billion investment during the next decade in command and control systems which may not perform their required missions when the chips are down.

Air Force electronics support system programs and requirements were analyzed in terms of four functional types of systems:

- **Command:** Systems intended to provide military commanders with battle situation information needed for making decisions and exercising control, such as SAC Control System (465-L), NORAD Combat Operations Center (425-L) and Air Force Control System (473-L).
- **Control:** Systems intended to directly control weapons, such as SAGE (416-L), and Air Weapons Control System (412-L).
- **Sensors:** Systems intended for detection and surveillance, such as DEW Line (413-L), BMEWS (474-L), Electromagnetic Intelligence System (466-L), and Samos/Midas satellites (117-L).
- **Support:** Systems intended to support a variety of weapons or other systems, such as Air Communications System (480-L) and Weather System (433-L).

Winter Study Group aimed some of its strongest criticism and recommendations at systems in the command area. They found that there has been too little consideration of how the systems would operate together, exchanging vital information available in one system which might be needed by another command. All of these systems employ automatic data processing and display equipment and require reliable communications.

Strategy Insight

The Winter Study Group found that it could not appraise the soundness of present command system designs without a clearer insight into basic national military strategy. The group therefore called in top level military strategists, not only in the Air Force but in the other services and from the Joint Chiefs of Staff.

Although U. S. often has stated a policy of not launching the first blow, those who blueprint command and control system designs must know if there are any conceivable conditions under which this policy might be altered.

If the nation is committed to holding back the launching of its ballistic missiles, despite electromagnetic evidence of coming attack provided by BMEWS and Midas satellites, until warheads actually fall, then perhaps less money should be spent on such sensors and more should be spent on hardened bases and communciations, the group concluded.

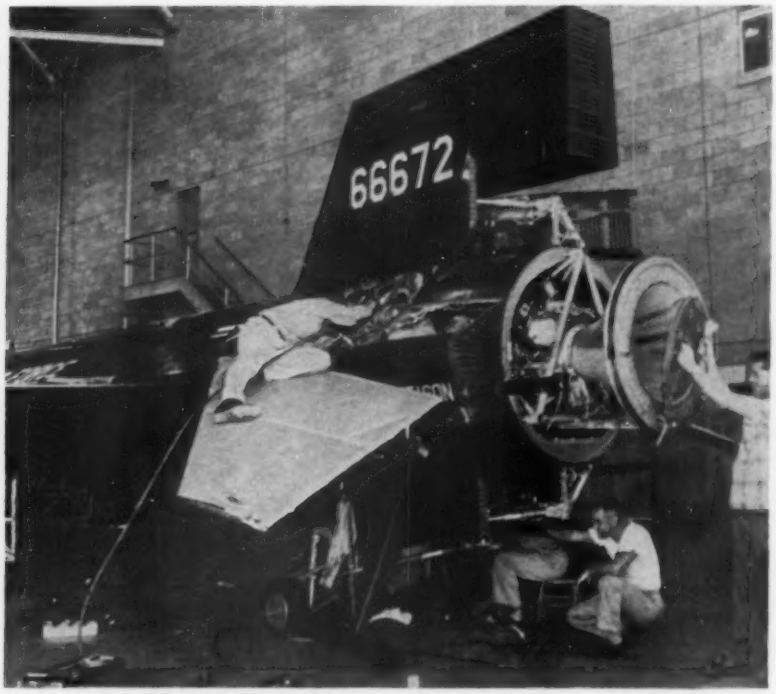
Command and control systems for use with weapons intended to withstand the initial attack should be designed not primarily for sophistication and quick reaction capability, but for survivability. Those intended to control soft weapons like SAC bombers should have quick reaction capability at the expense of survivability.

"There is a real danger that command and control systems will 'fall between the two stools,' being neither reliable enough to permit us to launch a quick strike before being hit by a suprise attack, nor survivable enough to control our reaction after being hit," according to Maj. Gen. Kenneth P. Bergquist, commander of Air Force Command and Control Development Division here. Winter Study Group was formed by AFCCDD.

Wrong Emphasis

The Winter Study Group found evidence that there has been too much emphasis on system features which are primarily for controlling forces prior to an attack, and too little on controlling forces after the initial attack.

To achieve the necessary integration of command and control systems and to assure that they can be built within available state of the art, funds and time, the Winter Study Group urged



XLR-99RM-1 Engine Mounted in X-15

Thiokol XLR-99RM-1 liquid propellant rocket engine, rated at more than 50,000 lb. thrust, is mounted in North American X-15 research vehicle at Edwards AFB, Calif. Powerplant length is 30 ft., including tankage. Propellant flow is 12,000 lb./min. Engine was scheduled for first flight test last week, with Scott Crossfield as pilot.

that full responsibility and authority for system design decisions be given to a single agency. The Command and Control Development Division, formed here after the Winter Study Group got under way, is the logical group to provide this function.

Operating commands would still be responsible for spelling out their operational needs, but the single agency would make design decisions that affect integration with other support systems. The agency also would serve as a consultant to operating commands to assist them in appraising merit of alternate approaches and techniques.

Also recommended was a single strong planning and analysis activity to develop plans and concepts for application to future command and control systems. This function presumably would be performed by The Mitre Corp., although it is not identified by name.

More than half of the members of the Winter Study Group came from AFCCDD and Mitre Corp.

The group's report also calls for more attention to the problem of speedy and reliable communications between individual groups within an operating command headquarters. In event of war, there must be provision for rapid transfer of information between intelligence, plans, operations and materiel elements.

Gen. Bergquist calls for better understanding of the command and control system design problem throughout the operating commands. Military commanders need to recognize that the application of automatic data processing systems to their command and control needs may result in sharp changes in the traditional way of doing things.

Winter Study Group also emphasized the need for evolutionary introduction of command and control systems, to assure smoother transition from the old to the new.

House Group Calls for Reoriented, Better Coordinated Noise Research

By Ford Eastman

Washington—House Science and Astronautics Committee called last week for better coordination of government noise research programs and a bigger effort to solve current aircraft and rocket noise problems.

Committee said National Aeronautics and Space Administration and other agencies should concentrate more on current problems, noting that NASA appears to have reoriented its noise research program toward the future noise problems of manned space flight, the sonic boom phenomenon and the supersonic transport. Level budgeting of the NASA noise research program also was noted, while "noise problems are more acute than ever before."

Committee charged that while there is considerable noise research under way in government laboratories, there appears to be a lack of common orientation except in the services through the Armed Forces-National Research Council Committee on Hearing and Bio-Acoustics (CHABA). Committee reported on "Noise: Its Effect on Man and Machine."

Committee recommended that:

• "**A set of criteria** be developed by a single, impartial, government agency which does not have any regulatory responsibilities. It is suggested that the Armed Forces-National Research Council Committee on Hearing and Bio-Acoustics is the ideal group to undertake such a project, since all interested government agencies have an affiliation with this committee. In addition, the CHABA has the respect of industry and the scientific community.

• "**NASA increase its emphasis** on noise research, particularly in re-emphasizing research in solving the noise problems of today's jet airliners.

• "**Noise criteria** be a mandatory requirement in the drafting of specifications for future military and civil aircraft, rockets and missiles, consistent with the necessity for military performance.

• "**Basic research** and development effort into the effects of noise on man and machine be increased commensurate with the recognized seriousness of the problem.

• "**Closer cooperation** and exchange of technical data, through CHABA, be implemented by industry and the scientific community.

• "**Congress amend** the Federal Aviation Act so that it clearly delineates Federal Aviation Agency responsibility for fostering research and development relevant to noise control planning for civil aviation.

• "**National Science Foundation** encourage more basic research in investigating the anatomy of noise. Research grants should be increased to emphasize the importance of the need to study the psychological and sociological unknowns abounding in the subject of noise and its effect on man.

• "**NASA became a full** member-partner with the three armed services, and the FAA in providing funding support to CHABA instead of remaining an affiliate member of the committee. In addition, NASA should rely on CHABA for noise program orientation.

• "**All so-called informal** government cooperation be formalized and channeled through CHABA.

• "**Formal federal government,** local government and industry symposia be planned under the sponsorship of CHABA as an initial step toward planning a nationwide attack on the noise problem."

Noise suppressors currently attached to the rear of all jet engines in use on commercial transports today have been only moderately successful in reducing the exit noise of turbojet engines by about three to six decibels and can only be considered an interim fix, the report said. These suppressors also reduce the thrust of the engines by as much as 2-4%, which is an economic factor of concern to the commercial air carrier.

Memorandum Cited

Committee cited a memorandum from Stuart Tipton, Air Transport Assn. president, as an example of added costs to the airline because of the suppressors. Tipton said: "The use of noise suppressors results in an average 4% increase in flying time and fuel consumption on short-range flights. They account for an average 2% increase of flying time, and a 9% increase in fuel consumption on long-range flights.

"As of Aug. 1, 1960, there were 13 U.S. air carriers operating a total of 169 turbojet-powered transports. A cost accounting breakdown of the additional monthly operating costs due to the use of suppressors made by one carrier now operating a fleet of 24 jet aircraft shows the increased operating costs and payload loss amounts to $240,932.49 monthly.

Applying this figure to the total turbojet fleet now in operation, we can conclude the carriers now operating turbojet aircraft are paying approximately $1,700,000 per month for noise suppressors." The committee estimated that in addition, engine and airframe manufacturers have spent between $30 million and $50 million in noise suppressor research and development.

In another area, boundary layer noise creates several problems for jet aircraft, rockets, missiles and manned space craft, the committee said. These problems are sonic fatigue of the basic vehicle structure; interference with speech communications; noise-induced failure of instruments, instrumentation, guidance systems, and auxiliary power supplies; and for the astronaut, possible psychosomatic problems during re-entry.

TSR.2 Prototype Contract Awarded

London—Major policy decision to proceed with construction of a radically new type of STOL tactical strike and reconnaissance aircraft has been made by the British government with announcement of a firm contract placed with the British Aircraft Corp. for a prototype and preproduction quantity of TSR.2 fighters by Harold Watkinson, defense minister.

The TSR.2 will be built by the Vickers-Armstrongs division of BAC at its Weybridge plant and will be powered by two advanced versions of the Bristol-Siddeley Olympus twin spool turbojet delivering 33,000 lb. of thrust each with afterburning (AW Feb. 2, 1959, p. 37). The afterburners have been developed by Solar Aircraft Corp. of San Diego and are built under license in England by Bristol Division of Bristol-Siddeley.

First flight of the TSR.2 is scheduled for 1963 with initial operational capability in Royal Air Force squadron service programed for 1965. Basic performance characteristics include high subsonic speeds at extremely low altitudes and high supersonic speeds at high altitude. The TSR.2 is designed to make its target penetrations at extremely low altitudes, below any possible defensive radar coverage, and will be capable of these low level operations in all types of weather.

It will have a minimum combat radius of 1,000 mi. and in its STOL configuration can take off with a full combat load from any field large enough to handle a DC-3. Despite considerable Vickers research in variable geometry aircraft the TSR.2 will not employ this type of design.

The TSR.2 will also be capable of considerably extending its range and armament load by operating from normal bomber-length runways and it is likely that it will be considered for supplementary roles as a strategic bomber from this type of field.

Construction of the TSR.2 prototype has already begun at Vickers' Weybridge plant.

This is the second STOL-VTOL type fighter under development in Britain. The Hawker P.1127, powered by the Bristol-Siddeley BS 53 turbofan lift jet equipped with swiveling jet nozzles to provide both vertical lift and forward propulsion, is now completing final taxi tests and is expected to make its first flight before the end of the year.

Top USAF officials have been briefed on the TSR.2 project and although no firm commitments have been made, there is a possibility it may be considered to meet USAF's Tactical Air Command requirement for a STOL strike fighter.

New Nuclear Weapon Drop Missions Flown

Las Vegas—New supersonic "laydown" technique of nuclear weapons delivery was included as a competitive event for the first time in the USAF "William Tell" fighter weapons meet here.

The laydown missions were flown at a subsonic speed of 480 kt. because most of the aircraft competing were older North American F-100 fighters which cannot exceed Mach 1 at low altitude. For the sake of uniformity, the one team equipped with Lockheed F-104 fighters also made its runs at 480 kt.

The laydown mission approach, release and escape are all made at low altitude—about 50 ft. The nuclear bomb to be used in actual missions would be delay-fused and would carry a nose spike to embed in the ground or the roof of the target. The theory of the laydown attack is that with the head-start provided by the delay fuse the fighter-bomber moving at supersonic speed will be able to stay ahead of the nuclear shock wave moving at Mach 1. The effects of heat and radiation on the airplane after the detonation are calculated to be tolerable since only the airplane's tail and trailing edges would be facing the burst.

Another type of mission flown for the first time in the meet is the "drogue retarded" drop. Both attack techniques were developed by the Air Force Special Weapons Center at Kirtland AFB, N. M. The drogue retarded delivery has a profile in which the bomb is lofted above the release point and a drogue opens to stop the bomb over the target and gives the fighter bomber a few moments to escape the detonation. The bomb would ordinarily be altitude-fused.

Soviets Issue Crash Report on Viscount

Moscow—Soviet investigators have found that the crash of an Austrian Airlines Viscount near Moscow on the night of Sept. 26 "was essentially caused by the fact that the plane descended prematurely at a great distance from the airport. That is why it caught against treetops, crashed down and burst into flames," according to a Tass report on the findings of the Commission of Central Civil Airfleet Administration (Aeroflot).

The craft crashed and burned while making a landing approach to Sheremetyevo Airport, killing 30 persons and injuring seven. The accident occurred in conditions of bad visibility.

Representatives of Austrian Airlines and the Civil Aviation Administration of the Austrian Ministry of Transport and Electrification cooperated with the Aeroflot commission in the investigation and, according to Tass, arrived at similar conclusions.

Tass said the commission believes the premature descent might have been caused by an attempt of the crew to pierce as soon as possible a low cloud blanket and fly visually. The commission pointed out the possibility that a premature descent might have been caused by an error by the crew in estimating actual altitude because of errors in altimeter indications or because of the fact that the altimeters "in the cockpit were set at different barometric pressures as has been established by investigation.

"The commission found that all ground radio and light facilities at Sheremetyevo Airport needed for flight guidance functioned faultlessly," Tass reported. The dispatcher services were transmitted on time and the plane crew received all information needed for a safe landing, Tass reported.

News Digest

Convair-Pomona has a $41,303,720 production contract for the Tartar shipboard surface-to-air missile.

First USAF-Convair Atlas E, using more powerful Rocketdyne engines and a larger nose cone than earlier models, was fired from Cape Canaveral, Fla., last week but fell short of test objectives apparently because the sustainer and vernier engines shut down too early.

United Aircraft Corp. has acquired a 20% interest in Societe Precilec, Paris electronics company, and similar interest in Societe Somalec, an engineering affiliate of Precilec. Precilec will have exclusive rights to licensed production of Norden Division products for European Common Market.

Army has chosen the Bell HU-1A turbine-powered Iroquois as its new instrument trainer and purchased 14 for delivery to Army Aviation School, Ft. Rucker, Ala., where classes will begin late this month. First five specially instrumented HU-1As have been flown away from Bell's Hurst, Tex., plant.

OFFICE OF THE PRESIDENT • THE KAMAN AIRCRAFT CORPORATION • BLOOMFIELD, CONN.

MEMO TO JOHN:

Thank you for your letter in which you express your preference for Kaman helicopters. As you put it:

TRRffIC IN HEIICOPTERS. YOUR That is the truth. It sure is ~~that is~~ the truth.

..

Everyone here at Kaman Aircraft is proud of the helicopters and aircraft we build and supply to various branches of our Armed Forces. It makes us doubly proud when boys like you write and tell us what you think. We know that you realize that our whole National Defense program is one sure way of guaranteeing that you and your friends will get the chance to grow up and become terrific doctors or lawyers or scientists... maybe even terrific helicopter pilots.

Sincerely,

Charles H Kaman

...in National Defense KAMAN is part of the plan

**Facsimile of a letter to the company

THE STRANGE STORY

Clutching frantically at the empty ammunition drum of his Lewis gun, the British pilot held on and prayed. Thrown from the cockpit as his Martinsyde Scout flicked over into a spin, he dangled helplessly as his plane flew upside down in a rush toward earth. In seconds, he let go of the drum with one hand, risked a grab for a sturdier hold on the center section strut—and found it. Now his chin was rammed against the top plane, beside the gun, but his legs still fanned empty air. Through the propeller he could see the town of Menin and a revolving kaleidoscope of French countryside.

Desperately, the pilot kicked backward and up toward the cockpit behind him, shattering the instruments on the dashboard. Finally he got both feet hooked inside the cockpit and edged them toward the stick.

Once the stick was between his legs, he jammed on full aileron and elevator. The Martinsyde quickly righted itself and the pilot fell back into the cockpit and crashed through

his seat, jamming the controls. The machine was still racing down in a dive. He cut the engine off, braced his shoulders against the top of the fuselage and his feet against the rudder bar, thus freeing the controls. Seconds later he pulled out of the dive, skimming the trees that lined the Menin road, and hurried back to his base heedless of the German ground fire.

It was May 10, 1915—a day that Captain Louis A. Strange, a flight commander of the Royal Flying Corps' No. 6 Squadron would never forget.

It had started with Strange's pursuit of an Aviatik B. II on a reconnaissance mission over the British positions. At 8,500 feet, both planes were nearing the tops of their ceilings. As the German observer potted at Strange with a Parabellum pistol, he emptied a drum from his Lewis gun, but with little or no effect. The empty drum jammed as Strange moved to replace it, so he wedged the stick between his knees and tugged at the drum with both hands. Finally, he raised himself half out of the cockpit to get a better grip. In that instant, the climbing Martinsyde stalled and flipped over into its spin. Strange was thrown clear of the machine, still clutching the drum.

Louis Strange learned to fly on a bet in 1913. He was in the vanguard of British aviation units that arrived in France in August, 1914, and piloted the first British plane armed with a Lewis machine gun.

Strange progressed through the early campaigns of the war flying rickety Avros, Farmans and B.E.'s. A masterful tactician and leader, he was promoted rapidly through command and staff posts. He flew and fought throughout the war and was commander of the 80th Wing during its last six months of duty. A Lieutenant Colonel at war's end, he held the D.S.O., M.C. and D.F.C.

The Martinsyde S.1, the plane Louis Strange flew on that harrowing day in May, 1915, was developed as a result of early successes with single seater scouts. It appeared late in 1914, but because of its poor stability and limited ceiling was withdrawn from service on the Western Front in the summer of 1915.

Heritage of the Air

One of the most inspiring chapters in the history of technical evolution is the story of the men and flying machines of World War I. It is the highly personalized story of brave men — and the wood, wire, linen, and rudimentary technologies that converted manpower to airpower. Today, Leach Corporation celebrates its 40th year in electronics with the presentation of this Heritage of the Air series.

* * *

Technical Director for Heritage of the Air is Lt. Col. Kimbrough S. Brown, USAF

(Advertisement)

Even the Russians are talking about Leach Relays...

Серия

Вычислительная техника

Экспресс-информация

Раздел

Узлы и элементы вычислительных машин и устройств

ВСЕСОЮЗНЫЙ ИНСТИТУТ НАУЧНОЙ И ТЕХНИЧЕСКОЙ ИНФОРМАЦИИ ГКНТ СССР и АКАДЕМИИ НАУК СССР

Июль 1959

Выпуск 29 / № 97-100 /

87-97-84

Рис. 2. Фотография элементов схемы рис. 1

Featured here in a leading Soviet Union technical magazine with some well chosen words of approbation is a Leach magnetic amplifier relay. It's the device shown in the center of the photograph.

Although Leach products, through Leach International S.A., have been widely used by our Nato friends for years, we were somewhat surprised by this recent Russian endorsement.

Apparently the Russians also know a good design job when they see it.

For a full English translation, we refer you to an article by Leach Engineer A. O. Adams, published originally on page 87 of the April, 1959 issue of *Electronic Industries*.

For power conversion systems, electronic subsystems and electromechanical components to meet the requirements of the space age...

LOOK TO LEACH

LEACH CORPORATION, 18435 Susana Road, Compton, California

Dutch Force Political Issue on Bilateral

U. S. ability to bargain strictly on economic basis questioned in KLM drive for route to Los Angeles.

By L. L. Doty

The Hague—Current political drive by KLM Royal Dutch Airlines for traffic rights in Los Angeles again raises the question of whether the U.S. can cling to its long-standing policy of negotiating bilateral air transport pacts on a strictly economic basis or will be forced to surrender once again to international political considerations in its bargaining for routes.

KLM officials here admitted to AVIATION WEEK that The Netherlands, having failed to persuade the U. S. to grant entry into the West Coast market under a policy of economic reciprocity, has now made the issue an affair of state in a last ditch fight for the Los Angeles route. They insist, however, that this move in no way eliminates the commercial feasibility of the proposed route as a major factor in the case.

Here's how matters now stand with respect to KLM's drive for Los Angeles traffic rights:

• **Negotiations between the Dutch** and the U.S. on amendments to the 1957 bilateral agreement between the two countries collapsed in February when the U.S. flatly refused to grant KLM traffic rights in Los Angeles (AW Feb. 22, p. 25). The Netherlands delegation rejected the decision on grounds that it represented discrimination against Dutch national interests and that it implied non-recognition of freedom of air traffic and the principles of sound competition.

• **U.S. State Department holds** that economic benefits already enjoyed by KLM on its present routes to U.S. points are substantial and that the award of a new route to the West Coast would create an economic imbalance between the two countries in the international civil aviation area.

• **The Netherlands will make** another major bid for the route but will defer any such action until after a new Administration moves into the White House in January. Meanwhile, the Dutch are conducting a continuing and vigorous campaign with top Administration officials in the U.S. as a prelude to reopened talks. Most recent attempt to crack the firm U.S. stand was made in Washington last month by Dutch Minister of Foreign Affairs Dr. Joseph M. A. H. Luns in a long talk with Under Secretary of State, Douglas Dillon.

• **Present State officials** thus far have staunchly resisted Dutch pressures for a change in the U.S. position. White House could, of course, force a switch in this stand. What measures the Dutch will adopt in moves to persuade the new Administration to take such action are not yet known, but KLM officials here openly hinted to AVIATION WEEK that Dutch withdrawal from NATO may be one of the major repercussions resulting from failure to grant KLM its desired route. It is not considered unlikely by observers in the U.S. that the White House will decide that maintenance of international relations with the Dutch supersede any airline economic considerations at stake and instruct the State Department to grant the route.

Political Precedent

If this happens, it will not be the first time that political pressures have forced a deviation from policy. In 1957, KLM won traffic rights to Houston although the U.S. was granted no significant reciprocal economic benefits in return in a move to ease relations with the Dutch. Earlier, Federal Republic of Germany was given a wide range of routes in 1955 covering services to Boston, New York, Philadelphia and beyond to points in the Caribbean and South American areas as well as to Chicago, San Francisco and Los Angeles as a means of bolstering Germany's budding economic growth pattern.

The KLM problem re-emphasizes the growing threat of a drastic change in U.S. civil aviation policy—a switch from free competition in all markets to tighter control of Fifth Freedom traffic (AW Aug. 1, p. 47). The granting of new routes to foreign flag carriers now serving the U.S., coupled with the basic requirement of giving entry to newly formed flag carriers of nations with which the U.S. has bilateral agreements, could force the U.S. to revise its over-all concept of competition on international routes (AW Oct. 10, p. 42).

On a commercial basis, the U.S. holds the upper hand in its bargaining with the Dutch. The Netherlands seeks entry into Los Angeles as an important source of revenue. It estimates that potential traffic volume between Amsterdam and Los Angeles is about 7,000 passengers annually.

The U.S., on the contrary, is satisfied with the routes it now holds under the bilateral agreement with the Dutch, seeks no extensions and, therefore, needs to make no bargaining concessions. In the case of its agreement with the United Kingdom, the U.S. wants several route concessions from the British (AW June 20, p. 88) and may be forced to trade away at least two new routes to get what it wants.

The Netherlands claims it is restricted in its operation to the U.S. as contrasted with the complete freedom of air that the U.S. enjoys. KLM now holds four route permits under the terms of the bilateral pact with the U.S.: Amsterdam-New York, Amsterdam-Houston, New York-Curacao and Curacao-Miami. By comparison, the U.S. has traffic rights from any point in the U. S. to any point in Dutch territory—including The Netherlands Antilles and Surinam—to any point beyond. The Dutch say this represents unrestricted traffic rights.

The U.S. has argued that, under the principles of the Bermuda Agreement—which avowedly guides and directs present U. S. aviation policy, an over-abundance of Fifth Freedom or "secondary" traffic would be handled by KLM on a Los Angeles-Amsterdam route. In other words, the majority of such traffic would move from the U.S. to Amsterdam and beyond to third countries and would not, therefore, be traffic to which KLM is entitled under the Bermuda principles.

The Dutch claimed that KLM operations would remain consistent with Bermuda principles and that the large Dutch population in Southern California is the source of a sufficiently strong community of interest to ensure against an improper ratio of primary to secondary traffic. The Dutch also held that it is discriminatory to grant West Coast traffic rights to such competitors as Lufthansa, Air France, SAS and BOAC while denying KLM the same economic privileges.

The U.S. told the Dutch that West Coast rights were not available to any

airline which requested such rights, that they were granted only after an equitable exchange of economic benefits between the foreign flag carriers and U.S. carriers could be demonstrated. The Dutch answered that no further economic benefits could be granted U.S. carriers since they already hold complete freedom of the air and could begin Los Angeles-Amsterdam service at any time. "Oddly enough, they aren't interested in such an operation and yet they don't want us to perform the service," a KLM official said here.

U.S. insists that, while economic factors weighed heavily in making the decision against granting KLM the route, over-all relations in economic and political spheres were also brought into play in formulating the policy. It also was emphasized that the interests of U.S. domestic and international carriers were a major consideration.

The Netherlands answered this by terming it "strange" that the interest of "one or two" U.S. carriers is given precedence over the importance of air transportation to Dutch trading and shipping programs, major segments of the Dutch economy.

It is this stress on the importance of air transportation to the nation's economy that has created wide-spread interest in the case in The Netherlands and has elevated the issue to one of vital concern to the Dutch Parliament and top government officials. It is highly evident here and in Amsterdam and Rotterdam that the KLM fight for a West Coast route is a political issue and will continue to remain a thorny factor in U.S.-Dutch relations until it is resolved in favor of The Netherlands. At the same time, to grant the route would mean the establishment of a U.S. precedent which could result in requests for more routes into more U.S. cities by more foreign flag carriers.

Local Airlines Threaten to Block Board Drive to Close Mail Rates

Washington—Accelerated Civil Aeronautics Board efforts to put all local airlines on final mail rates by the end of the year probably will be nullified by the carriers' requests to reopen rates as soon as they become final.

This tactic is the weapon the airlines will use to keep the CAB from making them operate under the new sliding scale rate-of-return used in setting final mail rates (AW Sept. 5, p. 40). The threat was evident last week when the carriers jointly asked for an oral argument to reconsider the rate formula and told the Board a set of perpetually open rates would be the only alternative.

CAB has decided final mail rates should be set on a scale ranging from 9% to 12.75%, with each carrier's rate based on its debt-equity ratio. The airlines, most of them carrying high debt loads, maintain the Board should use a uniform, industry-wide 12.75% rate of return.

By filing for an open rate immediately after the CAB sets a final rate, an airline can avoid operating under the sliding scale formula, which applies only to final rates. An open rate provides enough subsidy for a carrier to break even, plus a 9.5% profit factor.

Local airlines also are urging the Board to classify convertible debentures as equity rather than debt for rate-making purposes. This is because the 21.35% allowed on the equity portion of a carrier's investment base is considerably higher than the 5.5% allowed on debt. This imbalance is designed to encourage the locals to reduce the debt factor in their debt/equity ratios.

The airlines argue that convertible debentures can be converted to stock and that they should be classed as equity. They point out that several carriers have made heavy investments in this type of debenture as a means of improving their equity positions in line with CAB's wishes. Their contention is that a ruling classifying these securities as debt under the new formula would give many carriers a rate of return lower than the 9.5% under open rates.

Adoption of a flat 12.75% return for all carriers, they said, would provide them with a return slightly higher than that of the eight medium-sized trunklines and improve the locals' opportunities to compete for new capital in financial markets. In addition, equity capital could be more easily attracted by the use of convertible securities. Additional subsidy cost which would be required with an across-the-board 12.75% rate would be about $1.5 million, or 3% more than the estimated $54.3 million required under the Board's formula, the carriers said.

Noting that the Board clearly recognized local service problems in setting the rate formula, the airlines claim CAB's final opinion "presents a paradox" since it recognizes that the local service industry is less attractive to investors than the trunk airlines, but provides the smaller airlines with a lower rate of return and operating margin. Application of the Board's formula will result in an average return on investment of only 10.38% for local service airlines compared with 11.25% for the Medium Eight trunks in the General Passenger Fare Investigation, and in addition, the return rate will result in a profit margin of only 5.6% on operating expenses for local carriers, compared with 9.3% for the trunks.

Emphasizing the value of issuing convertible securities as a means of raising equity, the airlines pointed out that in the period 1946-56, the Medium Eight trunks issued more than $118.2 million in such debentures and preferred stock, compared with only $25.8 million in common stock. By mid-1957, nearly $81.8 million of the convertible securities had been converted into common stock, they said.

As further proof of this method of finance in the local service industry, the carriers noted that Allegheny and Mohawk airlines have issued $9 million in convertible subordinated debentures this year, compared with the total current equity of $15.5 million for all 13 local service carriers.

The carriers are pressing for recognition of convertible securities as equity, but they emphasize that an over-all return rate would be preferable because it would eliminate the need for CAB's sliding scale formula. The flat-rate would be sufficient to cover future conversion costs of these securities while spurring their sale, they said.

In addition, the airlines noted that use of the over-all 12.75% rate would be compatible with CAB's proposed class mail rate plan designed to provide profit standards, based on mileage and flight frequency, for future use. Any CAB move to implement its sliding scale formula for local airline profits, based on individual capital structures, will conflict with the basic concept of a class rate based on uniform standards applicable to the whole local service industry, the carriers said.

United Reports Gains In Revenues, Profit

Washington—United Air Lines reported a net profit last week of $8,007,445 for the quarter and $9,711,535 for the nine months ending Sept. 30.

The airline said net earnings for the quarter were $7,075,303, plus a gain from sale of surplus aircraft of $931,142. Operating revenues for the period were $111,564,194 and operating expenses were $95,266,220. Operating revenues and expenses for the third quarter last year were $91,548,236 and $78,596,034, with a net profit of $6,965,812.

United reported a nine month net profit of $9,711,535, compared with $14,357,785 for the same period last year. Operating revenues for 1960 period were $278,910,126, while 1959 revenues were $257,977,822. Expenses for the same periods were $265,059,939 and $228,706,907 respectively.

IATA Traffic Delegates Discuss Adoption of Two-Year Fixed Fares

By Robert E. Farrell

Cannes, France—Carriers attending the International Air Transport Assn. annual traffic conference reportedly have agreed for the first time to accept IATA-fixed worldwide fares for two years instead of the normal one-year duration.

This "two-year principle" was generally considered to be the major achievement of the meeting which was expected to wind up its four-week session this past weekend. In other actions, 70 member airlines reaffirmed the rule which forbids sleeperette or berth arrangements on first-class jet flights and postponed until mid-January a demand by three U. S. carriers for a new North Atlantic cargo rate structure (AW Oct. 10, p. 39).

The two-year fare principle takes on added significance since most airline representatives here describe this fare negotiating session as a "status quo" meeting. Thus the present fare structure, with minor exceptions, may remain in force for two years beyond next Apr. 1, the date when most current fares expire. In practice, however, the two-year principle may not work as well as all that.

The idea behind the two-year principle is that IATA must find a way to reduce its annual and laborious chore of hammering out worldwide fares. Sessions often run well over a month, thus tying up top airline executives. A step in this direction was taken this year when procedural airline matters—normally taken up at the annual traffic conference—were dealt with in a special meeting last spring. This enabled the Cannes meeting to concentrate on the fare problem with the result that the four-week session will be one of the shortest in IATA's history.

The carriers also were willing to accept the two-year principle since jet equipment now coming into operation on most international routes means that a period of "equipment stabilization" now lies ahead.

Moreover, the two-year principle won't hamper any carrier from opening any fare on which it thinks an adjustment needs to be made. Putting it another way, future traffic conferences —instead of trying to go over the whole international fare setup—now will negotiate only those fares opened by an interested carrier.

Admittedly, opening one fare could touch off a reaction all along the international line. But IATA officials feel the two-year principle will go a long way toward limiting agendas of traffic conferences to be held in the future.

On the North Atlantic, however, the two-year principle won't go into effect until the carriers take another look at the region at a special meeting to be held sometime in late spring. By then, the carriers feel, they will have a better idea of the impact of the 17-day North Atlantic excursion fare which went into effect Oct. 1. The excursion fare was decided on at the IATA emergency traffic meeting in Paris last March.

At the spring meeting, North Atlantic carriers may also take action on group travel discount rates. Certain North Atlantic operators feel they must act quickly to meet growing competition over the North Atlantic from charter flights.

Another significant result of the Cannes session was reaffirmation of so-called "Paris principle" which bans any sleeperette or berth configurations on jet aircraft. The carriers, at the Paris session last March, reached general agreement that the speed of jets ruled out the necessity of offering anything but a comfortable legs-on-the-floor seat to first-class passengers. At Cannes, this principle was vigorously challenged by Qantas.

Qantas, which in earlier sessions had requested permission to offer four-abreast sleeperette seats with 10% surcharge—scaled down this request at Cannes to five-abreast.

No other carriers supported Qantas. V. H. L. Dubourcq of KLM, who was conference chairman, suggested that, since Qantas was isolated on the issue, the only way to keep the conference from breaking up would be if Qantas withdrew its request. The Australian carrier, which reportedly was under virtual mandate from the Australian government to get some sort of "legs-off-the-floor" agreement, finally dropped its proposal.

On North Atlantic cargo rates, the issue was sidestepped by simply scheduling a special meeting on the joint U. S. proposal for mid-January. Time and place of the meeting will be set later this year. The meeting will be restricted to North Atlantic cargo problems and only interested carriers will attend.

The U. S. proposal, put forth jointly by Pan American, Trans World Airlines and Seaboard & Western Airlines, is based on the need for a rating scheme which would be attractive to shippers, freight forwarders and the airlines. According to one European source, the four-point cargo proposal shapes up as follows:

- **Minimum shipment charge** amounting to $15 would be levied.
- **Lower register of rates** including fixed charter rates of 18 cents per ton-mile, a 9,000-kilo general cargo rate at 20 cents per ton-mile and specific commodity rates carrying minimum weight requirements between 250 to 5,000 kilos.
- **Middle register of rates** which would include a variety of specific commodity descriptions presently in effect along with specific commodities which currently carry lower rates than 25 cents per ton-mile but which haven't as yet turned up expected volume. This middle register would look like this:
- **(Based on ton mile:)** Zero to 45 kilos, 50 cents; 45 to 100 kilos, 40 cents; 100 to 250 kilos, 30 cents; 250 to 500 kilos, 29 cents; 500 to 1,000 kilos, 27 cents; 1,000 kilos and over, 25 cents.
- **Upper register of rates** made up of specific commodities now rated above 50 cents per ton-mile. This category would also include current surcharge rates applied to movements of gold bullion, animals and human remains.

Most carriers complained that the U. S. joint proposal was so sweeping it needed further study. The U. S. carriers argued that their project is needed in order to put cargo operations on a more economical basis and protect scheduled cargo service.

Trans-Texas May Buy Convair 240s

Dallas, Tex.—Trans-Texas Airways would add a total of 22 Convair 240 transports to its current 25-plane Douglas DC-3 fleet if it is successful in its bid to extend its route structure to some 15 million revenue miles, compared with the current approximate 9.6 million.

Hearings on the Trans-Texas bid in the Southwestern Area Local Service Case will open in Washington, D. C., before the Civil Aeronautics Board Oct. 31.

In preparation for its presentation, the local carrier has completed a contract with American Airlines for the purchase of seven Convair 240s, fully equipped, to cost $130,000 each, with 5% payable upon execution of the contract and 5% payable on delivery of the planes. Balance would be payable in 18 equal installments, contingent upon award of the routes it seeks and reaching a "satisfactory" agreement with its pilots on payment for flying the 240s.

The airline also has an option to purchase an additional one to five CV-240s from American, plus rights of first refusal on 10 additional airplanes, all at the $130,000 price, thus having available 22 CV-240s.

TWA Completing Finance Plan; Hughes Passing Control to Trust

New York—Final details of Trans World Airlines' financing program were being completed late last week following Howard Hughes' agreement "in principle" to relinquish his control of the carrier to a group of lending institutions through a trust agreement.

Under the proposed arrangement, Howard Hughes—sole owner of Hughes Tool Co., which holds 78% of TWA's common stock—would agree to place these holdings in a trust which would give voting control to the lenders who will provide the bulk of the $340 million TWA needs to finance its jet equipment program. Initial plan calls for two trustees representing the lenders and one representing Hughes Tool Co.

The trust agreement now clears the way for TWA to accept delivery of its fleet of Convair 880 turbojet transports, which have been on the ground in San Diego awaiting delivery. The original financing program was developed last summer (AW July 11, p. 49) but was delayed when Charles Thomas resigned as president of TWA (AW Aug. 1, p. 29).

The lenders refused to close the transaction until a chief executive with whom they could conduct business was named. Meanwhile, the carrier's board of directors has met in a series of special meetings, trying to find some means of consummating the financing program. As of late last week, no further special meetings had been called prior to the next regular meeting scheduled for Oct. 27.

Long drawn-out process of working out details of a trust agreement that would be satisfactory to both Hughes and the lenders also contributed to the delay in completing the financing. Lending group includes Equitable Life Assurance Society of the United States, Metropolitan Life Insurance Co., Lehman Brothers, Dillon, Read & Co., Lazard Freres and a group of banks headed by Irving Trust Co.

Although Fred Glass, board chairman of the Empire State Building and former airline official, still appears to be the leading candidate for TWA's presidency (AW Oct. 10, p. 25), several other prospects are known to be under consideration for the post. TWA has been without a chief executive since the resignation of Thomas.

Selection of a new president and completion of the financing program probably will pave the way for action on the proposed merger between TWA and Northeast Airlines (AW May 23, p. 38).

TWA's original financing program called for $340 million, including the issuance of $100 million subordinated debentures to be offered stockholders. Under the initial plan as filed with the Civil Aeronautics Board, Hughes Tool Co. agreed to purchase, if necessary, a share of the debentures in proportion to the 78% of common stock it holds. Such a purchase would give Hughes Tool approximately a 90% interest in TWA, a possibility which the CAB has approved.

Hughes also agreed to lend the airline $50 million if necessary to keep the company's working capital above the $10 million mark. The original borrowing program also involved loans from banks and insurance companies totaling $190 million to bring the financial package up to a total of $340 million.

Under the new program as it is now being developed, this amount will probably be reduced to about $318 million since the amount to be provided by insurance companies and banks will be cut to $168 million—an amount now deemed sufficient to cover the airline's basic equipment requirements.

TWA now is operating a fleet of 27 Boeing 707s and has 30 Convair 880 turbojet transports on order from Convair Division of General Dynamics Corp.

One 880 has been in operation at the airline's Kansas City operations headquarters for pilot training purposes.

Total of 20 Boeings are on lease from Hughes Tool Co., and TWA now owns the other seven. The financing program will be used to buy the Boeing fleet from Hughes Tool, and for the purchase of at least 20 of the 880 models. It is not yet known whether TWA will ultimately purchase the full fleet of 30 880s ordered in the original contract with Convair, although a tentative arrangement has been completed calling for the lease of six of the fleet to Northeast pending completion of the merger proposed between the two companies.

World Employes Group Pushes Resolution Adoption, Despite Fight

Geneva—Government and employe representatives, polling what amounted to a bloc vote, succeeded in pushing across eight resolutions on international airline employment conditions at the conclusion of a 12-day meeting here of an International Labor Organization ad hoc committee on civil aviation (AW Oct. 3, p. 41).

Four of the eight resolutions were solidly opposed by the employer delegates of 18 nations represented at the tripartite conference but passed with an easy majority through the combined government-employe vote.

All resolutions were mildly worded and represent, at best, a hesitant step toward balancing employment conditions among the various international airlines. Resolutions opposed by the employers but approved by majority vote proposed that:

• **ILO director-general** "undertake studies of procedures whereby flight or ground personnel, who by loss of license or by technological developments in the industry have been prevented from performing the work for which they have been engaged, may be provided with alternative employment based upon retraining in accordance with their skills and qualifications upon retraining . . . either in the air or on the ground or with financial compensation determined in accordance with the normal negotiating practice in the [airline] industry."

• **Director-general,** "in consultation with the International Civil Aviation Organization," determine "how far the employe is protected or may be protected" against civil liability claims brought against him or his estate as a result of accidents and that he review practices in various countries concerning employment of stewardesses "with a view of ascertaining the position both in relation to termination of employment on marriage and on reaching a fixed retirement age." Employer group had no objection to the first proposal but contended that stewardess' employment conditions were outside the ad hoc committee's jurisdiction.

• **Director-general study** conditions of employment "of personnel engaged in air navigation services, with particular reference to the question whether these conditions are such as to attract suitable personnel . . . and to retain them. . . ." Employers contended that since the majority of personnel in this category are government employes, working conditions and practices should be settled directly between the individual governments and the airlines concerned.

• **ILO continue** "to give attention" to "many and varied social problems" within the airline industry created by its "international character and rapid technological development." Employ-

ers denied that employes were confronted by "many and varied social problems."

Even milder resolutions accepted by unanimous vote called on the director-general to initiate studies of employe workloads, social standards and employer responsibility for repatriation on termination of service; to consult with other bodies studying occupational health risks "with a view to the coordination of the results," and emphasized "desirability of consultation at the company level and/or national level, according to the practice of the country concerned, upon such subjects as may be agreed between the parties concerned."

Most, if not all, recommended studies probably will be ordered by the ILO governing body and their results passed along to the 83 member states belonging to this UN organization.

Continental Settles Flight Engineer Strike

Washington—Continental Airlines' flight engineer strike was settled last week when 14 of the striking engineers agreed to join the Air Line Pilots Assn. and eight were discharged.

The settlement, which was opposed by the Flight Engineers International Assn., calls for the 14 engineers to be placed on the ALPA seniority list. The eight not agreeing to the settlement terms will receive severance pay.

FEIA moved to avoid losing the Continental chapter and the strike by placing the chapter under control of officials in union headquarters here. This was done before the settlement was reached, and FEIA maintains that the eight discharged engineers remain a legal bargaining unit.

FEIA contends that the basis for the strike was that while its members have been pilot qualified in accordance with company policy, a planned change of crew complement on turbojet transports would have resulted in ALPA members handling all duties on the aircraft. Agreement with Continental's plan, the union said, would have resulted either in the FEIA chapter being forced to join the ALPA seniority list or being denied a jet berth.

Meanwhile, the union is still awaiting court action on a suit filed against Continental in San Francisco on grounds that the company has violated terms of the Railway Labor Act by negotiating with ALPA over crew complement issues directly involving the engineers. Also still in the courts is a $1 million damage suit filed by Continental against FEIA officials, contending that advertisements and publicity placed by the union during the strike were libelous and damaging.

House Group Enters Controversy Over Boston Harbor Electra Crash

Washington—Controversy over the cause of an Eastern Air Lines Electra's crash into Boston Harbor intensified last week as a full scale congressional investigation of the accident was launched by the House Transportation and Aeronautics Subcommittee.

Subcommittee, headed by Rep. John Bell Williams (D.-Miss.), conferred with Civil Aeronautics Board and Federal Aviation Agency investigators during a tour of Logan International Airport, where the Lockheed turboprop aircraft crashed on takeoff with a loss of 61 lives. Public hearings on the crash have been scheduled by the group for Nov. 15.

Meanwhile, Federal Aviation Agency Administrator Elwood R. Quesada reported that initial examination of wreckage recovered so far indicates that two of the aircraft's engines failed after the Electra flew into a flock of several thousand migrating starlings.

Quesada's early statements that bird impact, rather than any structural failure, may have caused the crash, brought charges from airport officials that FAA was aware of the bird problem at Logan but had failed to take any action.

The FAA chief replied that the hazard from flocks of sea gulls at the airport had been thoroughly discussed for some time between FAA, airport officials, air carriers and wildlife organizations. Pointing out that "all practical action" had been taken on the matter, Quesada emphasized that the Massachusetts Port Authority, as the operator of Logan, is responsible for the removal of any hazardous condition on airport property. He added that airport officials had repeatedly stated that the presence of starlings is unusual at the airport, and they never had been sighted prior to the accident.

Sen. Vance Hartke (D.-Ind.), who in the past has demanded the Electras be grounded because of their accident record, renewed his demands in a strongly worded letter to Quesada in which he promised to fight any move to reappoint the FAA administrator.

Replying to Quesada's comments that Sen. Hartke has made his demands for grounding of the Electra "out of a background of technical ignorance and with no real knowledge of the specific facts involved," the senator said the aircraft's safety record "speaks for itself."

"It is now obvious that Gen. Quesada intends to do nothing to try to prevent further loss of life in these planes," he said. "He has ignored safety suggestions given him by the Civil Aeronautics Board and has resolved all questions in favor of the manufacturer rather than public safety.

"I am now washing my hands of Gen. Quesada. The blood of any crash of an Electra is on his hands. I hope the next President will replace Gen. Quesada but, in the event he is renominated to be Federal Aviation Agency administrator, I will fight against Senate confirmation."

Initial reports from CAB investigators say that most of the Electra wreckage has been discovered, and all four turboprop engines are now being examined at the Allison plant in Indianapolis, Ind. Clear evidence that the number one engine failed has been found, they said, but there is no evidence at this point that the accident was caused by aircraft impact with starlings or ingestion of the birds into the engines.

Sightseers Hampered Electra Rescuers

New York—Rescue operations following the Oct. 4 crash of an Eastern Air Lines Electra in Boston Harbor were seriously hampered by the surge of curious sightseers to the Winthrop, Mass., waterfront, jamming traffic and impairing the movement of emergency vehicles.

This problem of interfering spectators reached major proportions in the summer of 1959 when a Pan American Boeing 707-120 jet lost its landing gear on takeoff from Idlewild and circled several hours before making an emergency landing (AW July 20, 1959).

In the Boston incident, radio and television broadcasts alerted the public to the crash, which occurred near the shore of Winthrop. The town is located on a peninsula, and Chief of Police William F. Pomfret attempted to seal off the peninsula from everyone except residents of Winthrop and those engaged in emergency operations.

But the crowd got there first, Pomfret told AVIATION WEEK, and the streets were "jam-packed" with sightseers. Traffic blocked the movement of ambulances to hospitals and to the temporary morgue in the Winthrop police station.

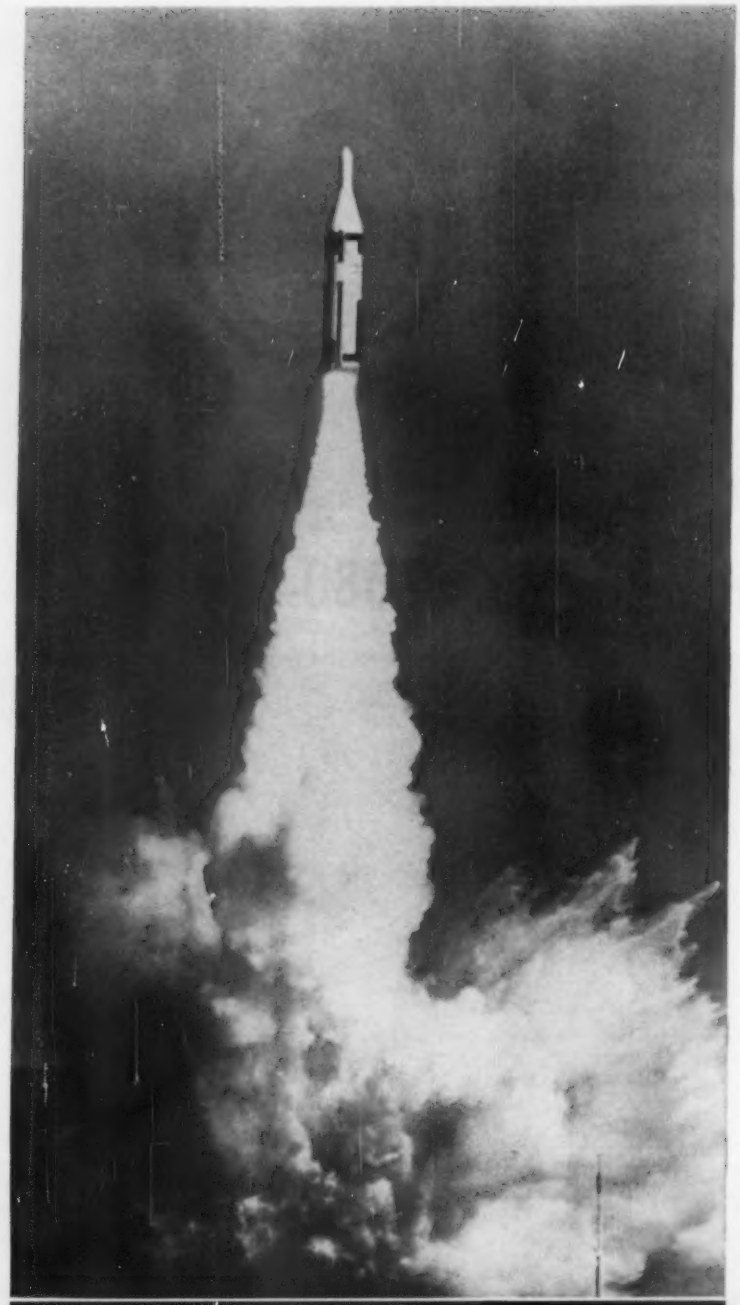
The radio "blatting out the news" brought "these senseless sightseers" to the scene, Pomfret said. Some persons parked and locked their cars in the streets, forcing emergency personnel to break car windows so the vehicles could be moved to let ambulances past.

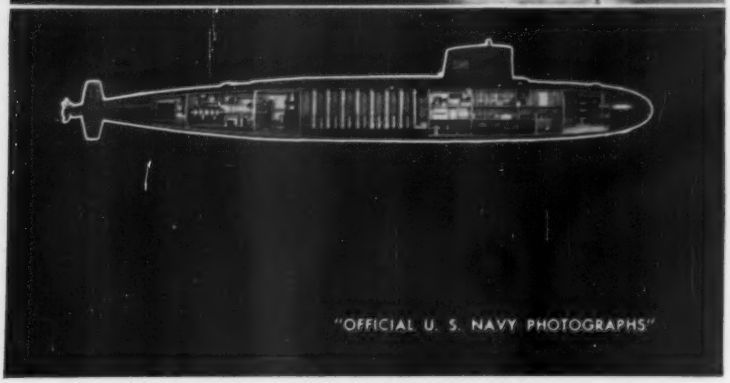
The police official said traffic was his biggest problem in the emergency.

First Convair 880-M made its first flight early this month. This flight-test aircraft is actually a converted 880.

Convair Will Begin Deliveries of 880-M in March

Three airlines have ordered Convair 880-M jet transports; the airlines and the dates on which they expect first delivery are: Civil Air Transport, Republic of China—March, 1961; Avensa of Venezuela, April, 1961; Japan Air Lines, May, 1961. These airlines' 880-Ms will have greater fuel capacity than the basic 880; the added fuel brings total capacity to 11,520 gal. and extends range by 780 stat. mi. The 880-M is powered by four General Electric CJ-805-3B turbojets each rated at 11,650 lb. at sea level, compared with thrust rating of 11,200 lb. for the 880's CJ-805-3s. Four slats on the leading edge of each wing-half of the 880-M move forward and down when flaps are actuated. With the aircraft in a nose-high attitude on landing or takeoff, the air passing over the wing passes under the extended slat, thus preventing separation of airflow from the wing and creating additional lift. Maximum zero fuel weight is 121,500 lb.



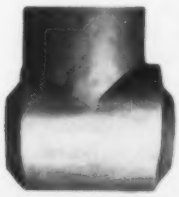


CAMERON HELPS PUSH POLARIS

Nozzles and structural members for Polaris and a number of other important U. S. Missiles are forged by Cameron from molybdenum, titanium, tantalum-tungsten and other exotic metals.

Cameron forged stainless steel check and gate valve bodies are a vital part of the nuclear power plant in submarines of the type which fire Polaris.

Our unique forging processes, which make us a significant supplier of these critical Polaris forgings, afford many distinct advantages in the production of these and many other vital components of the national defense program.



Check Valve for the Hot Loop of Nuclear Propulsion System. These are the largest closed die stainless steel forgings ever produced.

A first stage Polaris Nozzle Liner forged from pure molybdenum.

Cameron

IRON WORKS, INC.

SPECIAL PRODUCTS DIVISION
P. O. Box 1212, Houston 1, Texas

PASSENGERS at Prague Airport board a Czechoslovak Airlines Tu-104 twin-jet transport, one of four in service.

Czech Airline Bids for Western Markets

By Edith Walford

Prague—State-owned Czechoslovak Airlines is making a strong bid to invade Western passenger and cargo markets, particularly in North and South America.

No longer content with gradually increasing and expanding its European route structure both within the Soviet bloc and in Western Europe, CSA currently is negotiating with Trans-Canada Airlines for an extension of its scheduled service from Prague to Montreal via Amsterdam (AW Oct. 3, p. 43).

Route Negotiations

The Czech carrier also is attempting to compete with Western operators on their already established South American routes and in Africa, where newly independent states are anxious to improve air services and the political climate is receptive. But CSA's negotiations to this end are still in early stages.

The Czech carrier already serves more than 20 major non-Soviet-bloc centers from Prague and just about as many different international airlines land and take off there on regularly scheduled flights. In 1958, CSA carried a total of 407,536 passengers including those transported on its non-scheduled aero taxi flights.

Last year, the figure was boosted to 567,788 with a further increase assured by the end of this year. CSA officials say they have high hopes of continuing the present rate of progress in the airline's over-all activities which would mean that by 1965 its traffic will have increased threefold over the full 1960 expectations.

In general, CSA is organized on similar lines to Aeroflot, the Soviet airline, concentrating not only on the transport of passengers and cargo, but including crop-dusting and pest control on collective, privately- and state-owned farms and woodlands in additional services offered.

The company plans to operate Russian-built 80-seat Ilyushin Il-18 turboprop transports on the new route to Canada early next year after delivery of its fifth aircraft of this type on order and to augment this service later on with turbojet aircraft.

The airline's fleet of Il-18s was grounded in August after the crash of an Aeroflot Il-18 on a flight from Cairo to Moscow, but the planes are scheduled to go back into service sometime this month (AW Oct. 10, p. 37).

A spokesman for CSA here confirmed that Trans-Canada Airlines has agreed to pool the transatlantic service into Prague and current negotiations between the two carriers are expected to be completed shortly (AW Oct. 3, p. 43).

The Czech carrier is making a deter-

ILYUSHIN IL-18 turboprop transport is background for a fashion show staged by CSA.

From jet aircraft and missiles to automobiles and fractional horsepower motors, Purolator filters are part of advanced engineering design

Sixty-five Purolator filters perform vital functions on the Boeing 707, 720, Douglas DC-8, Convair 600 and Convair 880. Purolator filters form an integral part of such missile systems as the Hawk, Polaris, Jupiter, Atlas Terrier and Hound Dog.

In fact, we filter *all* fluids vital to the proper operation of aircraft, rockets, automobiles and other machines – be they air, fuels, lube oils, or hydraulic fluids. In each case, the Purolator filter is designed specifically for the job.

Do you have an engineering development in mind that would benefit by filtration? We're the world's largest, most-diversified maker of filters. Chances are, one of our more than 2,000 units will do the job. If not – we'll design and make a filter that will. Let us know your requirements.

Filtration for Every Known Fluid

PUROLATOR

PRODUCTS, INC.

RAHWAY, NEW JERSEY, AND TORONTO, ONTARIO, CANADA

mined effort to overtake its competitors and make good the serious setback it suffered as a result of World War II and again in 1950 when its foreign services were temporarily curtailed due to the general political situation.

A major step in this direction is the transformation of Prague Airport during the last year. Its maze of outdated buildings has been replaced by a modern control tower, longer runways capable of accommodating modern, heavy turboprop and turbojet transports, spacious new offices and a restaurant. There is still plenty of room for further expansion planned for the near future.

New Terminal

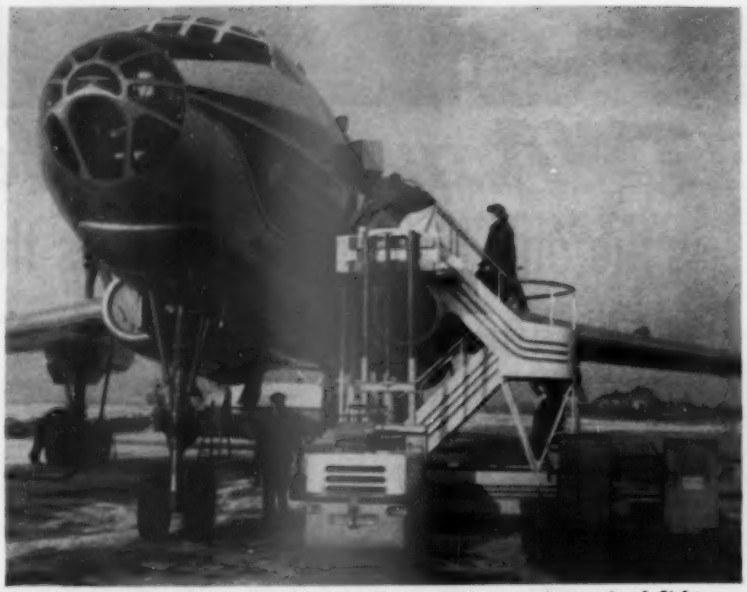
The airline's air terminal in the center of Prague, too, has undergone radical constructional change during the past year. Tastefully furnished, air-conditioned reception, booking and administration buildings with a good restaurant and bar have replaced the ramshackle sprawl of small, badly-equipped offices, which formerly depressed visitors. Multi-lingual personnel and surprisingly young airline officials in leading positions are alert and competent.

Step by step, CSA is modernizing its aircraft fleet. Apart from a handful of Douglas DC-3s still being operated on feeder services for shorter domestic routes, the airline depends primarily upon Russian-built Il-14s, Il-18s and Tu-104A twin-jet transports for its international and longer national route network. One exception to this rule is the Il-14s now in service which were produced under license by Avia Aircraft Works, Prague.

For shorter hops, CSA uses its Czech-designed and manufactured small aircraft of the three-seat Aero 45, four-seat Super Aero 145 and five-seat L200 Morava category. A modified version of the latter, L200 Morava A introduced at last year's Brno Trade Fair (AW Nov. 16, 1959, p. 85), is capable of flying nonstop on some of the shorter international routes—for example, Prague-London—with auxiliary fuel tanks installed in the wingtips.

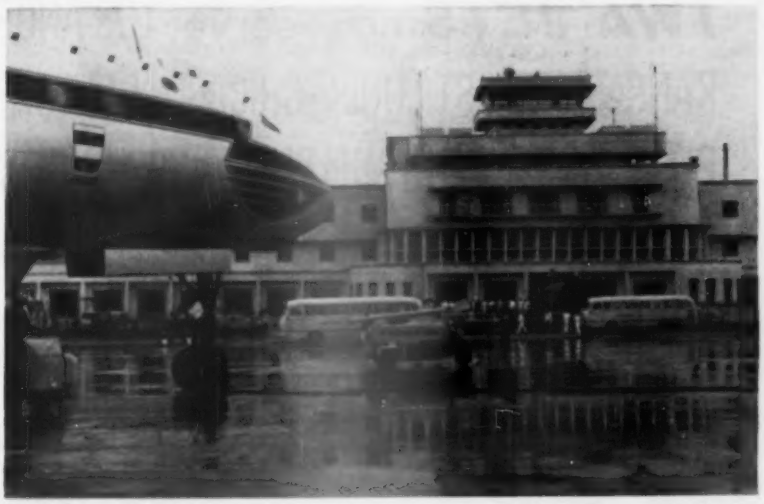
Average number of aircraft in constant service last year included 25 Il-14s; 3 Il-12s; 3 Douglas DC-3s; 3 Tu-104As; 5 L200 Moravas and 23 Aero 45s. Early this year, CSA completely phased out the Il-12s and took delivery of its first four Il-18s and one additional Tu-104A aircraft.

The company operates approximately 12 regular international round trip services twice weekly out of Prague: 32-seat Il-14s serve the Prague-Brussels, the Prague-Amsterdam, Prague-Vienna-Rome, Prague-Budapest-Sofia, Prague-Budapest-Bucharest, Prague-Lvov-Kiev, Prague-Belgrade-Teheran, Prague-Warsaw and Prague-East Berlin-Copenhagen-Stockholm-Helsinki route struc-



AIRLINE workers provision a Tu-104 jet at Prague, prior to an international flight.

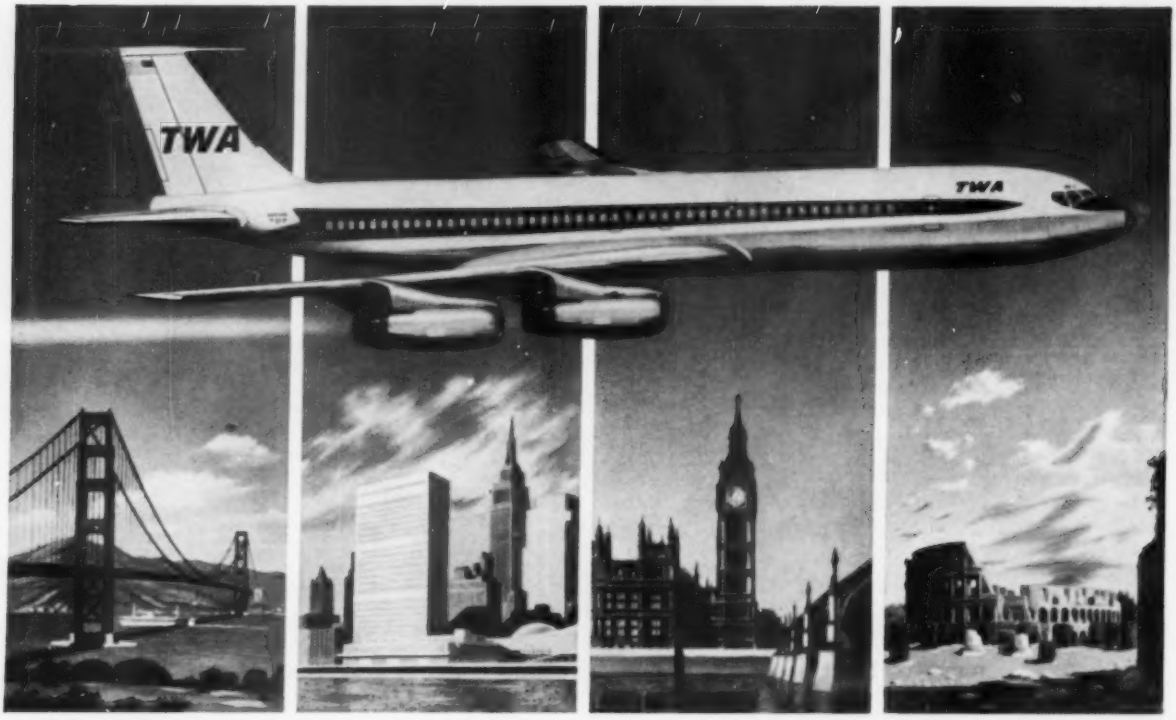
IL-14 transport in 32-seat configuration is shown ready to load at Vienna Airport.



TU-104, named for Brno, is parked at Bombay Airport. Air India buses are in front of terminal. CSA began new once-weekly service to Rangoon and Djakarta, via Cairo-Bombay.

TWA THE SuperJet AIRLINE

is the only airline flying across the United States...
across the Atlantic to Europe...and across Europe



TWA JETS now serve LOS ANGELES · SAN FRANCISCO
KANSAS CITY · ST. LOUIS · CHICAGO · DETROIT · NEW YORK · BOSTON
PITTSBURGH · PHILADELPHIA · WASHINGTON–BALTIMORE · MIAMI
LONDON · PARIS · ROME · LISBON · FRANKFURT · MADRID · ATHENS

FASTEST COAST-TO-COAST

Call your travel agent or nearest TWA office

TWA

*THE SUPERJET AIRLINE**

Call your travel agent or nearest TWA office

The only airline flying across the United States in 4 hrs. and 30 mins.

*TWA THE SUPERJET AIRLINE is a service mark owned exclusively by Trans World Airlines, Inc

Czechoslovak Airlines' Growth

	1959	1958
Unduplicated network mileage	14,150	11,280
Total miles flown per year	8,811,523	7,125,396
Average number of aircraft in service	67	68
Number of hours flown per year	43,675	37,664
Number of passengers carried	567,788	407,536
Passenger ton/mi. flown	14,378,210	10,276,680
Baggage ton/mi. flown	1,800,880	1,470,600
Cargo ton/mi. flown	2,041,800	1,383,900
Mail ton/mi. flown	2,431,620	1,829,380
Total ton/mi. flown	20,652,510	14,960,560

Fleet Roster

Aircraft Type	No. of Seats	Average Number of Aircraft in Service	
		1959	1958
Ilyushin-12 (*)	32	3	8
Douglas DC-3	26	3	1
Ilyushin-14	32	25	8
Tupolev-104A	70	3	3
L200 Morava, incl. pilot	5	5	8
Aero 45	3	23	9

CSA took delivery at the beginning of 1960 of four Il-18 and one Tu-104A additional aircraft.

(*) This type has been phased out in CSA's 1960 operations.

tures. The four 70-seat Tu-104As in service operate direct round trips from Prague to Moscow four times a week, Prague-London twice weekly, and Prague-Paris three times weekly.

Following delivery early this year of CSA's first four Il-18s, new route extensions were inaugurated early this summer once a week to Rabat-Dakar-Conakry and to Baghdad via Athens and Damascus. These two services are shortly to be increased to twice weekly.

In addition, on delivery of the fourth Tu-104A turbojet at the beginning of the year, CSA went into service once a week on another new route to Rangoon and Djakarta via Cairo and Bombay.

On Apr. 1, CSA also began a new round trip pool service with Alitalia into Rome twice weekly with Il-14s. Another plan is now being worked out to introduce a new route with Il-14s to Milan this winter, calling there initially about once every two weeks.

Major Terminals

Out of a total of some 100 airports, including private grass strips used for small aircraft, Czechoslovakia has three international terminals located in the major industrial areas of Prague, Brno and Bratislava. A fourth, presently under construction at Ostrava, will soon connect North Moravia to CSA's international route structure. This is an unusual feature in a country as small as Czechoslovakia. It also is an indication of the faith the country has in the rate of growth of air traffic within its boundaries.

On an average, CSA hauls more than 2,000 passengers in a total of 80 daily flights on its domestic routes, which in all connect 13 cities: Prague, Karlovy Vary, Brno, Bratislava, Gottwaldov, Olomouc, Ostrava, Sliac, Tatry, Presov, Kosice, Pietany and Lucenec. Longest national route is from Prague to Bratislava-Kosice, about 400 mi. served 10 times a day by Il-14s and twice daily by Il-18 aircraft.

The airline also operates a rapidly growing aero taxi service, which it claims was the first of its kind to be established on such a large scale in Europe (AW Oct. 19, 1959, p. 90). At Prague Airport CSA maintains a fleet of multi-purpose Aero 45s, Super Aero 145s and L200 Moravas on call at any time for these unscheduled flights. By removing the seats, these small aircraft can easily be adapted for a wide variety of duties—ambulance or for cargo-carrying purposes, for example.

CSA says that the average charge for these aircraft per flying hour and including the pilot works out at roughly $27 (380 Czech crowns) more or less, according to whether the smallest or largest of the three types operated is used. This is an exceptionally low figure, compared with the charges for similar service among operators in Western countries, but CSA declined to comment on whether the aero taxi service is being state-subsidized.

In step with increasing demand, CSA plans to augment the service with small helicopters, but no decision has yet been reached on which type it plans to purchase. Some observers here think

ANNOUNCING...

A NEW CONCEPT IN THE AIR TRANSPORT INDUSTRY

Contract Air Services for Airlines and Companies with Executive Aircraft

FLIGHT CREWS Fully Qualified, Experienced Flight Crews Now Available

International Air Service Company has experienced men to fly the line or help you train your own crews.

Completely U.S.F.A.A. Licensed, IASCO pilots are Airline Transport Rated in aircraft such as:—

Douglas DC-7 · Douglas DC-6 · Douglas DC-4 · Vickers Viscount · Lockheed 749 · Lockheed 1049 · Convair 240 and 440

...AND SOON JET QUALIFIED CREWS, TOO!

Also available top professionally qualified: NAVIGATORS • FLIGHT ENGINEERS DISPATCHERS • OPERATIONS AND TRAFFIC SUPERVISORS • MANAGERS AND CONSULTANTS.

INTERNATIONAL CREWS ARE BEST QUALIFIED BECAUSE:—

• RICH EXPERIENCE

Equal to that of any airline in the world. Pilot hours range from ten to twenty thousand—all accident free.

• VETERANS OF WORLD-WIDE FLYING

INTERNATIONAL men have schedule and charter flying experience dating back to the early 1940's, and have operated in every metropolitan high density center and on every continent.

• LOWER COST

INTERNATIONAL's costs are less than any comparable crew and training service.

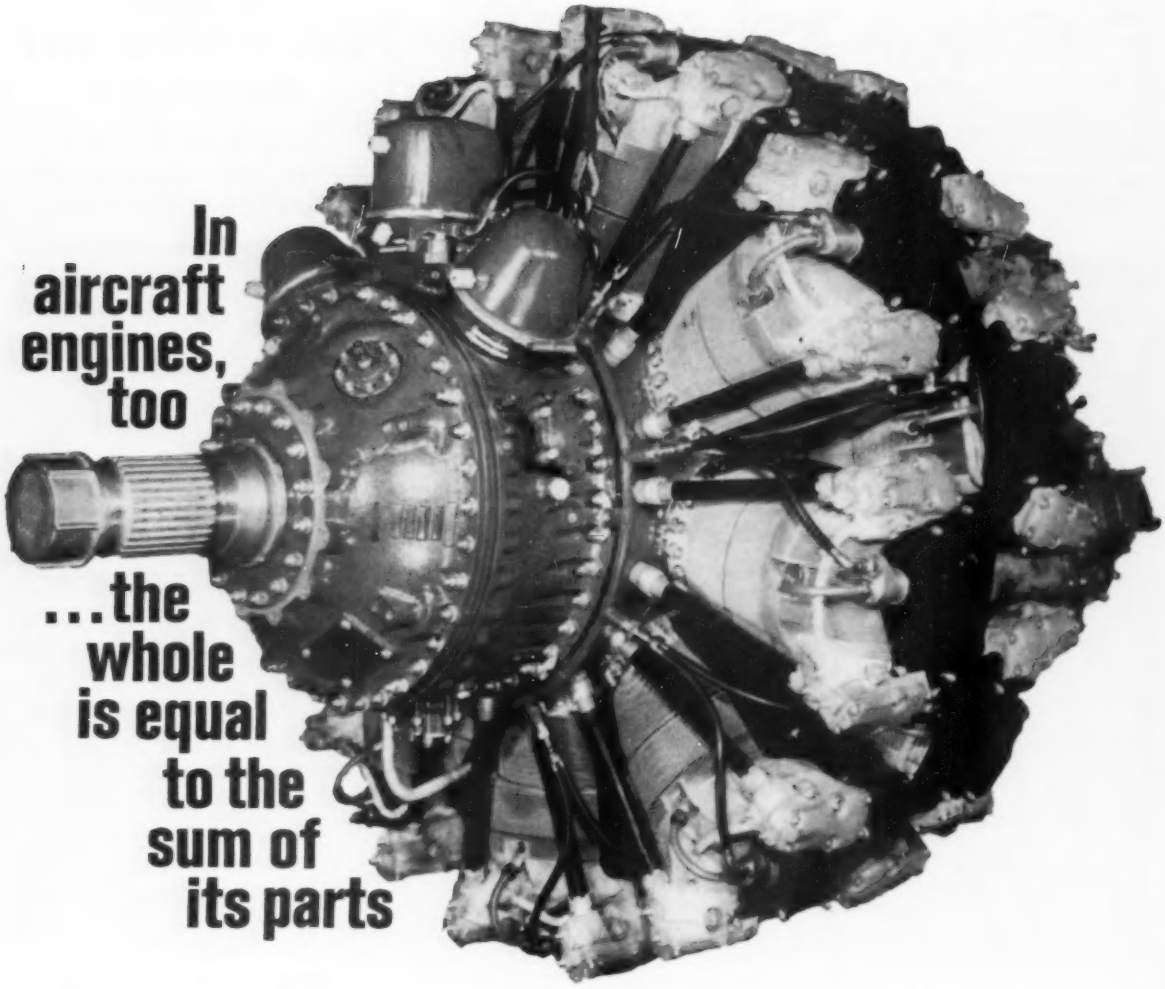
FOR FURTHER INFORMATION WRITE TO:—

INTERNATIONAL AIR SERVICE

INTERNATIONAL AIR SERVICE CO., LTD.

P.O. BOX 8483 SAN FRANCISCO INT'L AIRPORT, CALIF.

Home Office: 1299 Bayshore Highway Burlingame, Calif., U.S.A., Diamond 2-5734



In aircraft engines, too ...the whole is equal to the sum of its parts

An engine is only as dependable as its component parts. That is why Pratt & Whitney Aircraft engineers are never through designing, testing and refining. They are guided by this basic rule: Only the best is good enough.

When your engine needs replacement parts, ask yourself this: Are the parts equal to the whole? Parts not designed to Pratt & Whitney Aircraft engine requirements can wear out prematurely, cause severe wear and damage to other components. And remember, similar appearance does not always mean similar quality—your engine soon detects a difference that may escape your notice.

When you repair or overhaul a Pratt & Whitney Aircraft engine, make certain that replacement parts are original equipment parts. They are quickly available direct from Pratt & Whitney Aircraft or its authorized distributors in the United States and Canada.

PRATT & WHITNEY AIRCRAFT
East Hartford, Connecticut

CANADIAN PRATT & WHITNEY AIRCRAFT CO., LTD.
Longueuil, P.Q., Canada

that the new Czech six-seat piston-engine HC-3, a development of the HC-2 Heli-Baby, is a likely choice. The HC-3 is still undergoing flight tests scheduled to be completed by November.

Aerial crop-dusting and pest control of Czechoslovakia's collective, privately and state-owned farms and forests also are under the control of CSA, the only company in the country running this kind of special service. The Czech-built Brigadyr L 60 high-wing, utility type aircraft, is used for this agricultural work.

Czechoslovak Airlines relies on aero clubs and military sources for most of its pilots. Among the undisclosed total number of pilots the airline employs, it says it has 60 who have 1-million, 20 with 2-million and 10 who have logged 3-million kilometers' of flying experience.

Czechoslovak Airlines, State Corporation for Civil Air Transport, was founded July 28, 1923. Three months after its establishment its first flight was made with an open Brandenburg two-seat aircraft from Prague to Bratislava, a distance of approximately 199 mi., at an average cruising speed of 68 mph.

Early Routes

Gradually, more modern and larger aircraft, among them the Farman Goliath made under license by Avia Aircraft Works, Prague, were put into service to cope with CSA's expanding national network. In the mid-1920s the company joined IATA and began operations on international routes, including flights to Germany, The Netherlands, Austria, Switzerland and Poland. In 1934 the Polish route was extended to Moscow. By this time a number of new aircraft, such as the three-engine Fokkers and Italian Savoia-Marchetti capable of a cruising speed of about 103 mph. had been added to CSA's fleet.

Czechoslovakian aircraft were in service on scheduled flights from Prague to most major cities in Europe by the time World War II broke out.

Nazi occupation as well as the war meant the end of both civil and military aviation in Czechoslovakia. When hostilities ceased in 1945, CSA inherited only damaged airfields and several obsolete German Junker aircraft with which to resume operations.

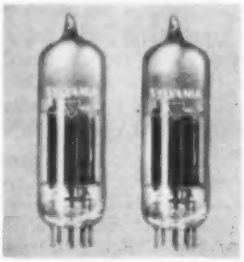
During the following year, it supplemented and replaced these older types with converted military Douglas DC-3s, gradually reopened its pre-war services and extended them to the Near and Middle East. Since then, with the exception of the 1950 period, when the international political situation forced the company to temporarily limit its foreign services, the airline has made slow but steady progress.

At 10 miles per minute "almost" reliable won't do

That's why the largest airlines rely on SYLVANIA GOLD BRAND TUBES in communications, control and navigation gear

SYLVANIA GOLD BRAND TUBES are built to take the demanding operation required in modern jet aircraft and still perform reliably. The popular Sylvania GB-5654, as an example, proves its dependability daily as an amplifier in aircraft communications receivers.

Gold Brand Tubes are disciplined to take impact shock tests of up to 750 g, fatigue tests for 96 hours at 2.5 g, and multiple life tests of 500 to 1000 hours. They undergo a multitude of stringent tests, including ability to withstand high degrees of vibration and thermal shock. Nothing is overlooked to give you the most reliable tube product available for the specialized needs of today's aircraft.



Specify Gold Brand Tubes—rugged, reliable AND readily available from your local Sylvania Industrial Tube Distributor. Ask him for the "Gold Brand Reliable Tubes" booklet. Or, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 1010, 1100 Main Street, Buffalo, N. Y.

SYLVANIA

Subsidiary of GENERAL TELEPHONE & ELECTRONICS

AIRLINE OBSERVER

► Philippine government's attempt to get a foreign air carrier permit for a route between Manila and San Francisco via Tokyo and Honolulu, even though it has denounced its bilateral agreement with the U. S. (AW June 13, p. 38), probably will be checked by Civil Aeronautics Board action. CAB examiner has questioned the right of the carrier to serve Tokyo on grounds that traffic between the U. S. and Japan is Fifth Freedom for a Philippine carrier and, as such, is not traffic for which the Philippines can make a valid reciprocal claim. On operating authority between Manila and San Francisco, the examiner recommended that the permit, if issued, should be canceled if U. S. flag carriers are restricted in their operations into Manila by the Philippines.

► **Watch for Pan American World Airways to double its freighter fleet by converting 10 additional Douglas DC-7Cs to all-cargo configuration. New DC-7Fs probably will incorporate the mechanized cargo loading system jointly developed by Douglas Aircraft Co. and Pan American.**

► Federal Aviation Agency's proposed rule widening lateral obstacle clearance requirements for turbine transports on takeoff has aroused the ire of local service carriers operating in mountainous areas. Under FAA's proposal, minimum clearances would be set by a scale keyed to whether a departure takes place during night or day or under visual or instrument flight rules. Carriers contend this would end Fairchild F-27 turboprop service at several western airports, forcing substitution of aging DC-3 equipment.

► **Mohawk Airlines plans to retire its fleet of DC-3s by the end of 1961. One of the fleet of eight has been sold to Trans-Sierra Airlines, and the balance are up for sale. The airline covers its major route segments with seven Convair 240s and four Convair 440s.**

► Continental Airlines is maintaining average daily utilization of 10.41 hr. with its Boeing 707 turbojet transports, highest obtained by a U. S. operator of any of the Boeing turbojet transport series. Best overseas utilization of Boeing jets is 8.72 hr. daily average recorded by Lufthansa.

► **Federal Aviation Agency has proposed a revision of rules governing restricted airspace areas that requires the agency to which restricted areas are assigned to submit annual reports to the FAA detailing activities in the area. The reports will enable FAA to evaluate the need for the restrictions. Proposed revisions would also require the controlling agency to authorize public transit of the area whenever possible.**

► Vertol Division of Boeing Airplane Co. is negotiating with Fuji Air Transport Co. of Tokyo for an agreement to purchase one Vertol 44 and two Model 107 transport helicopters for delivery in January, 1961. Aircraft will be used for regularly scheduled sight-seeing service in Japan.

► **Helicopter operators are currently the first, and possibly the only, subsidized carriers eligible to collect the full 12.75% rate of return recently voted by the Civil Aeronautics Board for local service carriers. Los Angeles Airways was permitted the 12.75% rate recently because of its 100% equity position. New York and Chicago Airways have similar debt/equity standings and would also be eligible for the full rate.**

► Air Traffic Control Assn. has named Clyde I. Denham, a Chicago Midway Airport tower controller, "Controller of the Year." The annual award is sponsored jointly by ATCA and the Air Transport Assn. "Facility of the Year" award has been presented to the Washington, D. C. Air Route Traffic Control Center. An Industrial Achievement Award also has been presented by ATCA to Intercontinental Electronics Corp. for pioneering development of radar-to-television bright displays for air traffic control.

► **Look for these sales of the first of the 40 Capital Airlines Vickers Viscounts which United Air Lines will acquire if the proposed merger materializes: seven to Northeast Airlines, five to Alitalia.**

SHORTLINES

► **Air Transport Assn.** has been denied permission to intervene in Civil Aeronautics Board hearings on a proposal to eliminate Part 294 of the Board's Economic Regulations, which governs blanket exemptions for carriers contracting with Military Air Transport Service. Board also denied motions for expansion of issues in the case of 20 supplemental carriers who would be affected by withdrawal of the blanket exemption.

► **British Overseas Airways Corp.** has set Dec. 8 for the beginning of New York-San Francisco-Tokyo-Hong Kong Boeing 707 turbojet flights. The new service is the result of a bilateral agreement between the U. K. and Japan. Service will connect at Tokyo and Hong Kong with BOAC de Havilland Comet 4 service flying eastward from London.

► **Kodiak Airways**, formerly an air taxi operator, has received a three-year certificate from the Civil Aeronautics Board permitting it to operate intra-Alaska routes.

► **L. T. U., Westdeutsche Fluggesellschaft,** has ordered a new version of the Fokker F-27 turboprop aircraft which can be converted from passenger configuration to all-cargo or combination cargo-passenger configurations. The German airline expects delivery in 1961 and has taken an option on a second F-27. This brings the number of F-27s on order at Fokker to 82.

► **Military Air Transport Service** has awarded two contracts totaling $426,249 to two U. S. all-cargo carriers. The Flying Tiger Line received a contract for $358,849 and Slick Airways was awarded a $67,400 contract.

► **Scandinavian Airlines System** has begun Douglas DC-8 service from Copenhagen to Anchorage and Tokyo via the polar route. SAS says flying time is six hours faster than in propeller aircraft. Initially, the Scandinavian airline will offer round trip flights twice a week.

► **Trans Caribbean Airways** has been authorized by the Civil Aeronautics Board to raise from two round trips weekly to three the number of flights it may operate between San Juan and Aruba, Netherlands Antilles, on flights to and from New York. The Board, however, denied authority to TCA to transport mail between San Juan and Aruba as well as New York and San Juan.

Your man at American AIRfreight®

American's Cargo Service Expediter—your representative at the freight terminal.

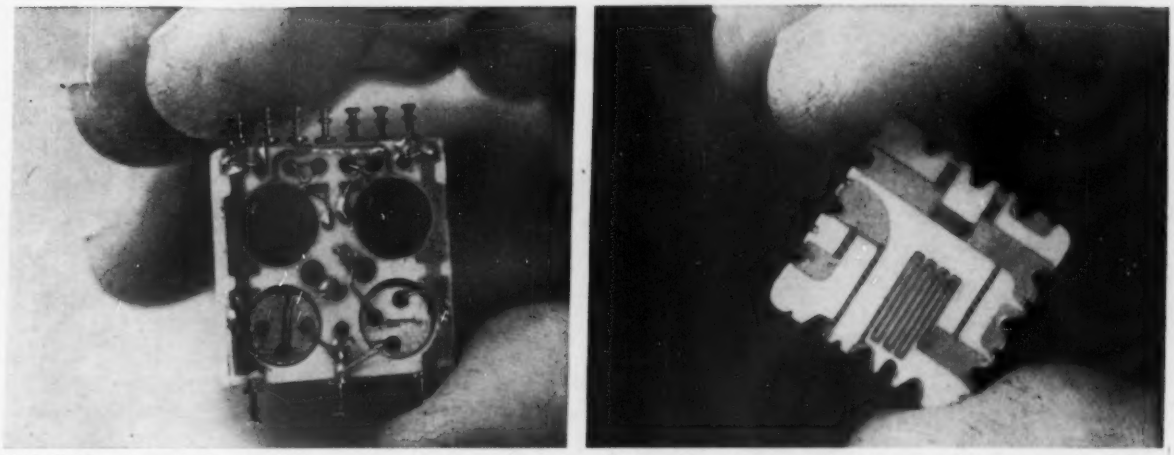
Your American Airlines' Cargo Service Expediter keeps a constant check on your shipment. He is the direct link between customer and carrier, and a big reason why you receive superior service when you ship by American AIRfreight.

Cargo Service Expediters, specialists among specialists, are a vital part of American's AIRfreight team. Every skilled member of that team has one goal: the swift, dependable movement of airfreight from shipper to receiver. This service concept is added assurance that your shipments with American AIRfreight leave on time, arrive on time and get where they're going in good condition.

Keep yourself abreast of the latest developments in AIRfreight. Write American Airlines AIRfreight, 100 Park Avenue, New York 17, New York, for a free subscription to "AIRfreight Manifest."

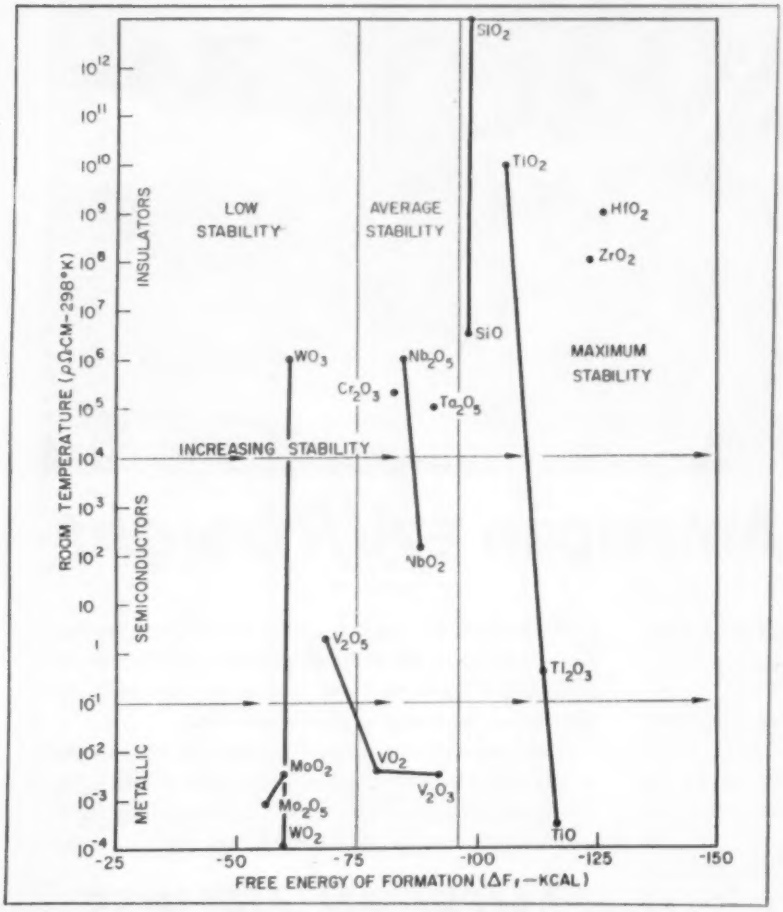
AMERICAN AIRLINES

America's Leading Cargo Airline



FLIP FLOP and two buffers employing passive circuitry made of thin titanium films are mounted on ceramic substrate measuring 1 in. x 1 in. x ¼ in. At right, nine resistors (two on reserve side), ranging from 4-560 kilohms, compose passive circuitry for d.c. amplifier.

Lockheed Develops Titanium Components



HIGH stabilities and varying resistivities of several oxides of titanium are compared with oxides of other metals. Lockheed Chemtronics program has succeeded in reproducibility fabricating resistors and capacitors from oxides of titanium.

By Barry Miller

Palo Alto, Calif.—Long-lived avionic components chemically fabricated from thin films of titanium and its compounds are being developed now in the initial phase of Lockheed Aircraft Corp.'s long-range research program aimed at providing the highly reliable components future satellite systems will require.

Stable, reproducible passive components—resistors and capacitors—are already being produced here at the Scientific Research Laboratories of Lockheed's Missile and Space Division.

Chemtronics Phase

First phase of the Lockheed research program under which both low-cost passive and active components are scheduled to be turned out is called Chemtronics—the use of chemical processes in obtaining electronic functions. The next and final two phases of the program, regarded by Lockheed as being less likely of realization until some time in the future, are dubbed Microfilm and Molecular Electronics. The entire effort is referred to as Microsystems Electronics (a generic term recommended within the American Institute of Electrical Engineers as the preferred designation for the various concepts of microminiaturization and molecular electronics). Forty people, including 14 scientists, are participating in the Lockheed Microsystems Electronics program, according to W. Dale Fuller, program manager.

A few of the features claimed for the titanium components which have or

soon will be made as part of the Chemtronics program are their:

- **Resistance** to radiation.
- **Ability to operate** at high temperatures.
- **Hermetic sealing** against moisture, alkali and many acids as an inherent byproduct of the resistor-capacitor film processing.
- **Stability** under various environmental conditions.

Titanium film resistors made to date meet or exceed the requirements outlined in MIL R-10509 C for fixed film resistors in all but one respect, Fuller says.

That one exception is the temperature coefficient which for this material is 200 ppm. per deg. C. Resistor films ranging in value from a few hundred ohms per square to over 8,000 ohms/square were fabricated and subjected to aging tests for periods in excess of 1,000 hr. (including several hundred hours at 65C, followed by several hundred hours more at 100C). Films up to 2,000 ohms/square experienced less than 1% aging over the entire cycle.

In other tests, maximum change in resistance for a series of resistive films (410 ohms/square to 2,700 ohms/square) over −55 to +165C was less than 0.5% at room temperature. Exposure to salt water immersion and thermal shock tests fail to affect the resistors, Fuller says. The 2,000 ohms/square resistance films show ¼% hysteresis between −55 and +250C.

While no efforts were directed toward optimizing resistance values, film resistors up to ½ megohm were fabricated, according to Fuller. The fabrication process makes precision resistors (to 0.1%) possible.

Program Objectives

Contrary to what the name Microsystems Electronics would suggest, the primary aim of the program is not to make components smaller. Rather, the general objectives of the Chemtronics program, now in its second year, are in descending order of importance:

- **Reliability.**
- **Producibility.**
- **Reduction** in size.
- **Low cost.**
- **Ease of maintenance.**

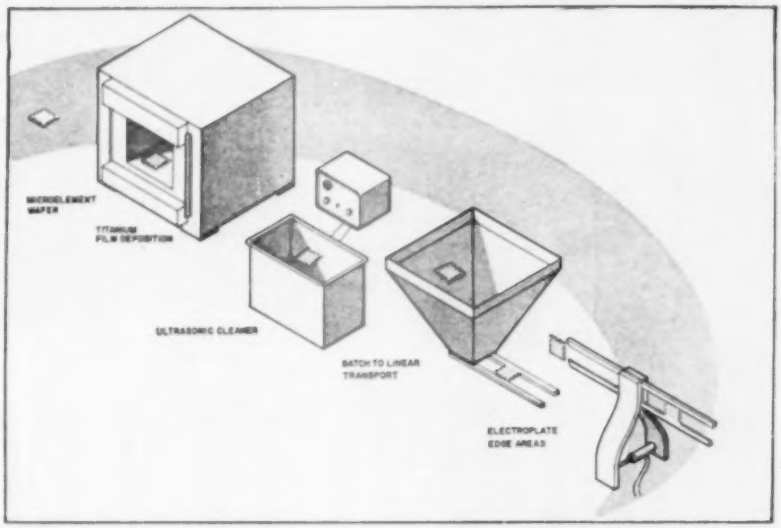
Attention of the Chemtronics program focused on refractory materials after an extensive search for those materials possessing high stability and providing a broad range of electronic phenomena. Titanium and its oxides were selected because of the wide range of electronic phenomena present in them. In the oxides, for example, Fuller points out, is titanium dioxide which has a dielectric constant roughly four times that of tantalum; titanium sesquioxide, a semiconducter; and titanium monoxide, a conductor whose resistivity is a factor of 100 times that of copper. All of these titanium compounds and many others are stable, Fuller explains, and give the scientists a chance to make a full range of electronic functions from the compounds of a single material. Even materials suitable as thermoelectric materials can be found among the oxides of titanium. In addition, the titanium sulfides tend to repeat this range of electronic phenomena.

Compared with tantalum, which has only a single stable compound, titanium is cheap, is more readily available, is easier to work with and is more stable, Lockheed's Microsystems manager says.

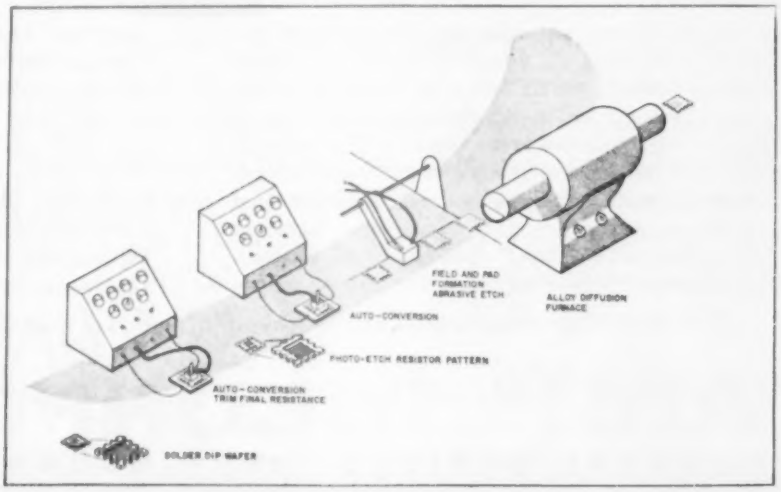
In making the films, one micron of titanium is deposited on ceramic substrates by a special oven process, the details of which Lockheed regards as proprietary. The deposition is accomplished in an inert atmosphere at approximately half the temperature required by the Molymanganese process, which is used in making ceramic-to-ceramic seals in vacuum tubes. The process can handle large batches of film substrates, perhaps 10,000 micro element wafers/hour. Cheaper than the Molymanganese process, the deposition doesn't subject the ceramic to the thermal stresses in the older process, Fuller says. The process can coat odd-angle exposures, such as plated through holes. This latter ability makes possible the realization of electrical coils from threaded through holes in a deep ceramic substrate.

Processing Components

This metallized ceramic substrate is the starting point in the processing of titanium components. Should the 0.31



TITANIUM film resistor is fabricated on a standard RCA-Army micromodule wafer in the illustrated process. The wafer is metalized, termination areas are affixed, a field pattern is etched, the field is converted into desired resistive film, the resistor pattern is photo etched, and the resistor is finally trimmed to precision value.



Certi-Crimp* • A-MP-O-LECTRIC • Plasti-Grip • SOLISTRAND • Plasti-Bond • AMP-O-MATIC • Amplifilm • AM

TION • COPALUM • Ampli-Bond • DYNA-CRIMP • TERMALUM • FASTON • AMPLIVAR • CERTI-SEAL • PIDG • A

MPOWER • DIAMOND GRIP • AMPORTAPOWER • AMP EDGE • Certi-Crimp • A-MP-O-LECTRIC • Plasti-Grip •

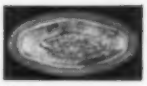
SOLISTRAND • Plasti-B… film • A… Bond • DYNA-C…

RIMP • …-SEAL • …PORTAP

*Registered U. S. Patent Office

INDUSTRY LEADERS

BECAUSE IT'S THE CRIMP THAT COUNTS!



All connectors may look alike but when faced with the test of performance . . . contact crimp reliability makes them all different. The big difference between other connectors and the AMPin-cert connector is the snap-in design contact attached to the wire by AMP's precision-controlled, compression-crimp technique. Twenty years of intensified research, development and production stand behind the industry-accepted compression technique which produced Solistrand®, Diamond Grip®, Pre-Insulated Diamond Grip®, Plasti-Grip®, Certi-Crimp® and the more than 15,000 different AMP circuit termination products. This is the common denominator which spells out unquestioned reliability in all our products including the AMPin-cert connector line. ANOTHER AMP FIRST! Now AMP offers tape-fed, automated application of AMPin-cert contacts. Production levels of up to 1,500 terminations per hour can be achieved with standard A-MP-O-LECTRIC® machines. Also, the AMPORTAMATIC crimping tool is available for tape-fed terminations in hard-to-reach locations.

Visit us at the A.E.S. Show, San Diego; Oct. 20-21, 1960, Booths 29 to 31.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

x 0.31 micro element alumina wafer employed in the Army-RCA Micromodule program be used, the steps in preparing the desired resistances are as follows: After the alumina substrate is coated with titanium, the 12 termination areas on the notched wafer are made solderable. This can be done in several ways at different points in the fabrication process. In one, sonic energy bonds the solder layer to the termination area. By dip soldering in a sonic pot, the edges of the wafer can be coated with solder and the excess solder selectively etched away during a subsequent step.

Alternately, Lockheed says, a diffused metallic composition can be placed on the pad areas, then solder-coated by a conventional dip process. Nickel can be electroplated on the edges of the wafer, followed by a flash overcoating of copper. Heat treating at 800C produces a titanium alloy around the edges of the wafer to which leads are soldered. To eliminate fluxing, Lockheed explains, a thin layer of gold can be electroplated over the edges.

In the next step, a field, or prescribed square metallic area connected to the termination points is created by etching material outside the prescribed region from the surface. The actual resistor pattern is not formed until after this titanium field pattern is converted into resistive material.

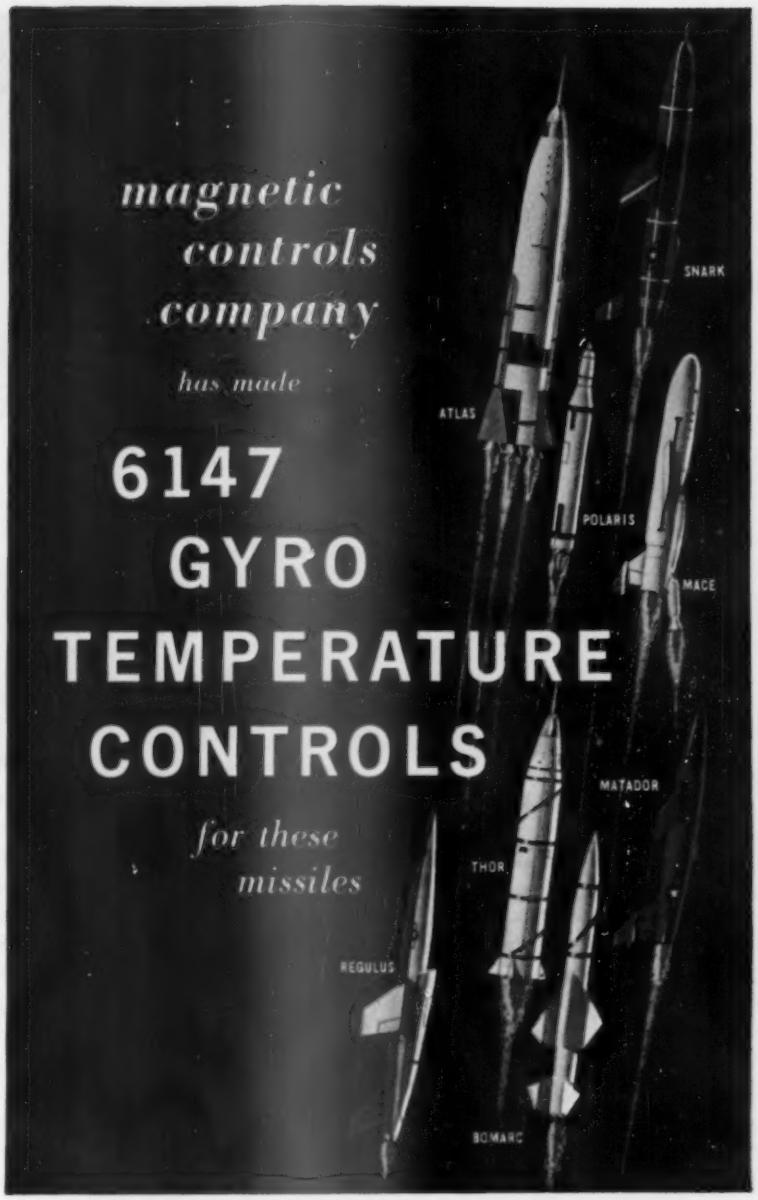
Conversion Process

The conversion of the field pattern into a suitable resistive film is achieved by a lengthy (up to 30 min.) electrochemical (anodizing) process. During anodizing, the resistance value can be monitored. A bridge circuit turns the anodizing process off within 1% of the desired resistance value (0.1% accuracy is possible with a better bridge). Current cutoff does not create any transient effect and the resistance value does not change when the substrate is removed from the process. Thus, a 0.1% resistor can be produced by the same processes and equipment required of a 1% resistor.

This last step effectively converts the titanium film into the desired ohms/square value by reducing the cross sectional area of the film and simultaneously has changed the top portion of the film into titanium dioxide, an effective hermetic seal.

The wafers can then be stored in different ohms per square values, ranging from the one ohm per square of the initial titanium layer to 2,000 ohms/square. When a specific resistor is desired, a resistance pattern can be etched for the specific resistance value.

Capacitors are made in essentially the same steps except that an additional titanium layer is added as the second electrode. Lockheed may eventually market the titanium capacitors



Missile manufacturers demand light, accurate, reliable gyro temperature controls—delivered on time. Magnetic Controls Company pioneered this field in 1952. Since then we have reduced the weight and size of these controls by 90% while *increasing* accuracy and reliability. This is why so many missile makers rely on Magnetic Controls Company. For experienced advice and detailed facts on specific applications, phone or write:

MAGNETIC CONTROLS COMPANY

6411 CAMBRIDGE STREET • MINNEAPOLIS 26, MINN. • WE. 9-4691

Heat Control Systems • Static Inverters • Voltage Monitoring Systems

LOW-SHOCK TRACKED MOBILITY FOR SENSITIVE ELECTRONIC EQUIPMENT

The tactical advantages of full off-road *tracked* mobility in military support vehicles have been well proved in many years of field operation. But the idea of transporting intricate radar and communications equipment and fully-assembled missiles over rugged terrain raises the question, "What about vibration and shock input to sensitive components?"

The answer – favorable. Carrying a simulated missile and sensitive oscillograph recording equipment, an FMC tracked vehicle ran a 2,000-mile shock test over our proving ground – on 60° slopes, over rough cross country terrain, and on high speed roads. Data returns showed that the vehicle's torsion suspension system effectively cradled the missile, with a low shock input factor.

For full details on these tests and other questions of adapting tracked mobility for your purposes, contact FMC, America's leading producer of military-standardized tracked vehicles.

For further information, write on company letterhead to Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, Calif. Phone CYpress 4-8124.

Putting Ideas to Work

fmc

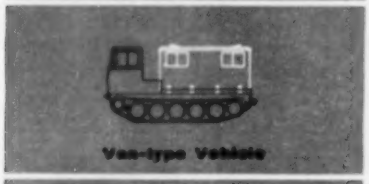
FOOD MACHINERY AND CHEMICAL CORPORATION

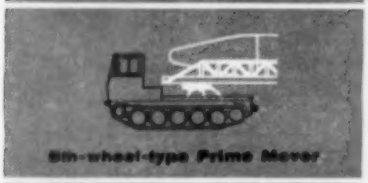
Ordnance Division

1105 COLEMAN AVENUE, SAN JOSE, CALIF.

fmc

Illustrated below are the M-113 and five vehicle adaptations of this basic tracked vehicle. All of the vehicles use the same military standard equipment, including engines, power train, and suspension components; thus reducing the military logistic burden and R&D costs in weapons systems.





FMC's Aluminum Alloy Welding Techniques Open New Horizons for Structural Applications

Machine welding heavy aluminum armor plate in FMC's Ordnance Division's shops.

Food Machinery and Chemical Corporation's recently developed welding techniques make economical heavy aluminum weldments possible. High strength, low weight, gas and liquid tight construction are a few of the characteristics available through modern welded aluminum fabrication. These techniques are ideally suited to the construction of vehicles – landing craft, barges, containers – on an economically sound basis.

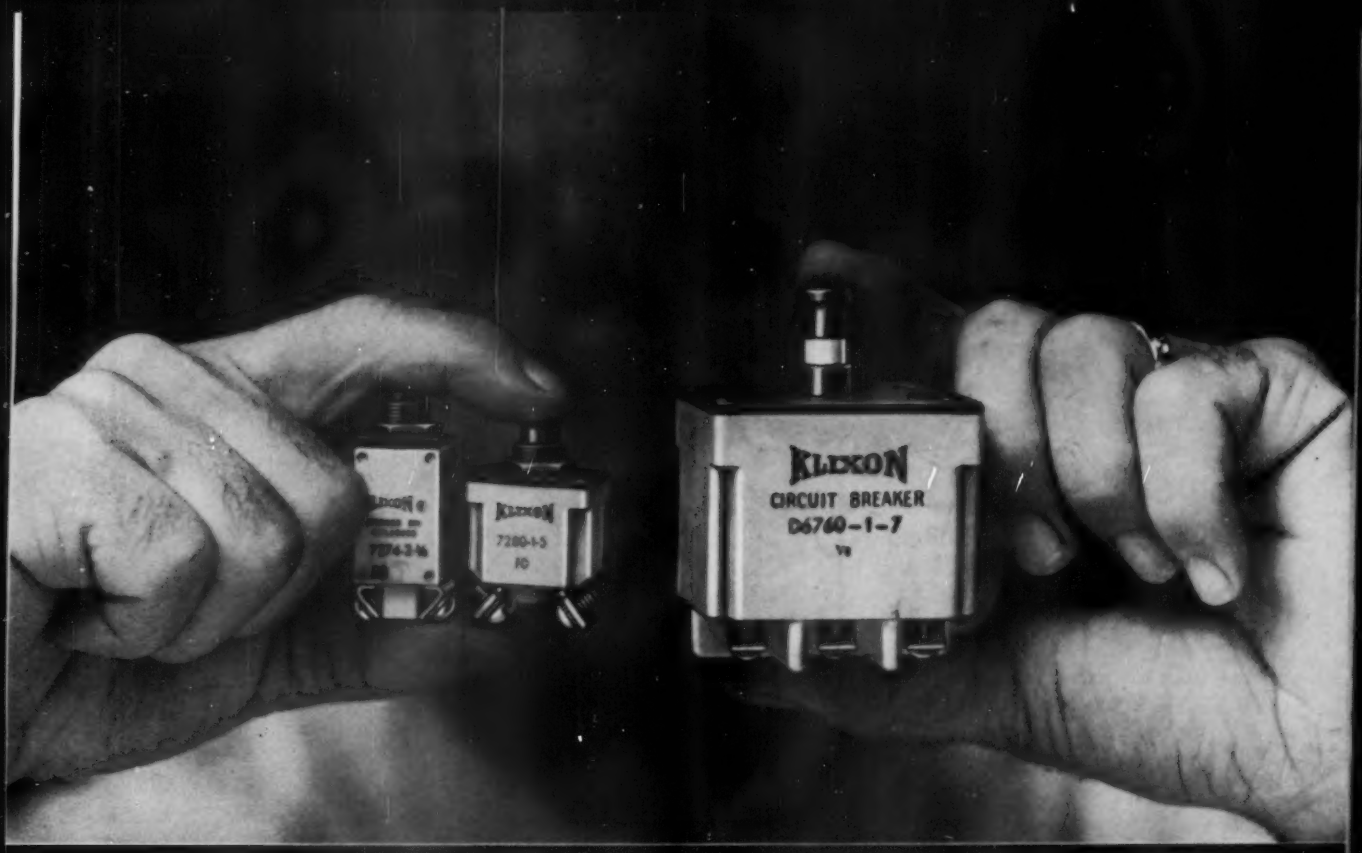
FMC's aluminum welding capabilities are the result of extensive research and development work performed in cooperation with military agencies to develop reliable, economical welding techniques for the production of the aluminum M113 Armored Personnel Carrier. Thousands of pounds of various aluminum alloys were formed, welded, machined and tested to select the best alloys and fabrication methods. Over a score of prototype M113's were then constructed and subsequently tested by military agencies to substantiate the vehicle's design and construction.

The economy realized through FMC's development of welding and fabrication techniques is an important factor... making the cost of the aluminum M113 competitive with the M59, its steel predecessor. Welding costs for this all aluminum vehicle were reduced through the use of –

Optimum joint geometry
Maximum use of welding fixtures
Maximum use of automatic plate preparation equipment
Maximum use of machine welding equipment
Maximum use of extruded shapes

These modern methods and facilities may provide the answer to your problems in procuring high performance equipment.

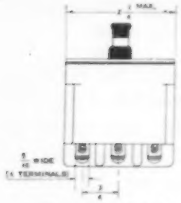
The new aluminum welding techniques developed for the M113 program and vehicle production, illustrates FMC's fully integrated capabilities and facilities.



Micro-Miniature — ½ to 5 amp. — 7274-2 Series • Miniature — 5 to 35 amp. — 7280-2 Series • Three Phase — Simul-Trip* — D6760 Series (MS24549)

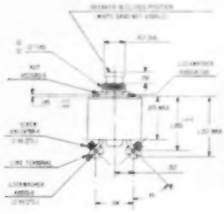
GET THE EXTRA SPACE SAVINGS – GET THE EXTRA RELIABILITY

Exclusive Characteristics of these KLIXON® Circuit Breakers



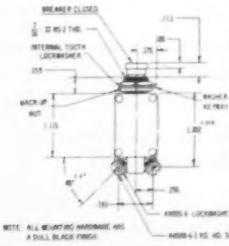
D6760 Three Phase (MS24549)

Thermal type. Interrupts high AC short circuits . . . trips quickly . . . provides simultaneous tripping of all three phases should any one phase become overloaded. Phases can be different ratings.



7280-2 Miniature

Trip-free, push-pull, 5-35 amp. circuit breaker providing maximum protection to aircraft and electronic gear cable plus exclusive weight and space saving advantages of 30% in volume, ½" in depth and 10 grams in weight.



7274-2 Micro-Miniature

Sets new standards in size, weight and performance. Fast tripping response provides positive protection for low thermal mass components in aircraft, radio and electronic gear.

Characteristics	7274-2 Series	7280-2 Series	D6760 (MS24549) Series
Performance	28 VDC and 120 VAC to 400 cps; all ratings unlimited rupture on 28 VDC; ½ to 1½ amps. unlimited rupture on 120 VAC. 2 to 5 amps. rupture capacity to 800 amps., 120 VAC on 120 VAC, ½ to 1½ amps. unlimited rupture, and 2-5 amps. 800 amps. rupture.	28 VDC and 120 VAC to 400 cps. All ratings on 28 VDC, 6000 amps. rupture; on 120 VAC, 2000 amps. rupture.	Min. AC rupture capacity 1500 amps., 3φ, 120 VAC, 400 cps; 2500 amps., 1φ, 120 VAC, 400 cps.
Ratings	½ to 5 amps.	5 to 35 amps.	5 to 60 amps.
Limits of ultimate trip (25°C)	115% min. 145% max.	Hold 115% Trip 138%	3φ balanced load: 105% – 138%; unbalanced load: two phases – 100% one phase – 145%.
Overload calibration at 200%.	2 to 20 sec.	7 to 45 sec.	3φ balanced load: 10 to 60 sec.
Max. operating force. Open and reset.	5 lbs. open and reset	8 lbs. – open 12 lbs. – reset	8 lbs. – open 15 lbs. – reset
Shock, minimum.	35 G's	25 G's	25 G's
Vibration, minimum.	10 G's to 2000 cps.	10 G's	Procedure I, MIL-E-5272, except 5 G level for 5 amp. rating.
Weight.	0.9 oz.	1.25 oz.	8 oz. approx.
Optional features.	Available with aux. control circuit (7274-4).	Available with special locking terminals (7280-6).	Available in 2-hole (D6760-4) or 4-hole (D6760-1) mounting.

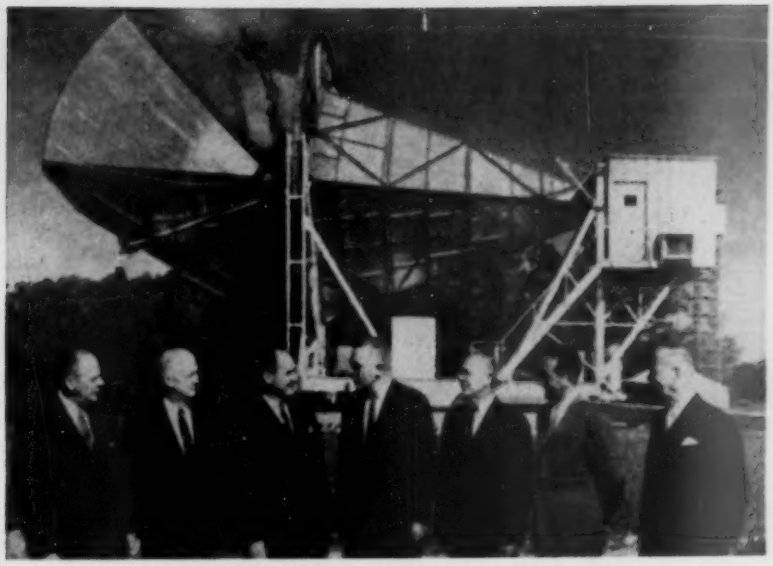
The D6760 three-phase breaker provides extra reliability because it is internally ganged — one button, one case, no mechanical linkage. There is none other like it. This breaker and the 7280-2 and 7274-2 are the smallest available — offering extra advantages in weight and space savings.

*Trademark of Texas Instruments Incorporated

Write for complete KLIXON Precision Circuit Breaker Catalog.

TEXAS INSTRUMENTS
INCORPORATED
METALS & CONTROLS DIVISION
2610 FOREST STREET • ATTLEBORO, MASS.

VISIT OUR BOOTHS AT THE AIRCRAFT ELECTRICAL SOCIETY SHOWS AT SAN DIEGO AND LOS ANGELES.



Picture Relayed by Echo I Satellite

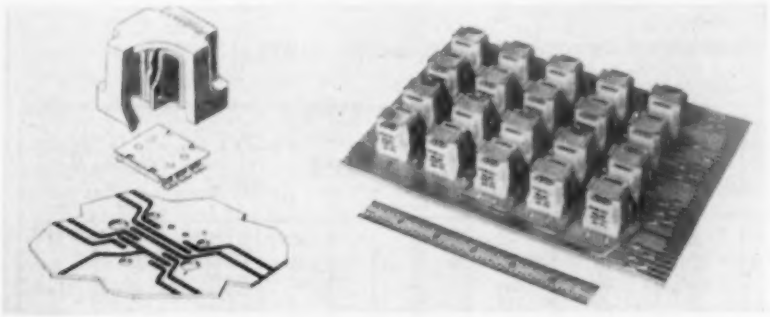
Members of Federal Communications Commission are shown in photo taken at Bell Telephone Laboratories, Holmdel, N. J., transmitted by land-line to U. S. Naval Research Laboratory, Stump Neck, Md., and then bounced off NASA's Echo I satellite back to Holmdel. Horn antenna shown in background was used to receive the picture. Left to right are Commissioners John S. Cross and Rosel H. Hyde, Dr. T. Keith Glennan of NASA, Frederick W. Ford, chairman of FCC, and Commissioners Robert T. Bartley, Robert E. Lee and T. A. M. Craven.

separately through its Maywood, Calif., Division, a spokesman there told AVIATION WEEK.

Research on semiconductor devices made of titanium sesquioxide films is progressing. Some rectifiers have been fabricated.

Another group at Lockheed is investigating a number of possible packaging schemes for interconnecting circuits made of titanium films. Circuits utilizing other types of ceramic substrates, thicker than micro element wafers and conventional encased transistors were made.

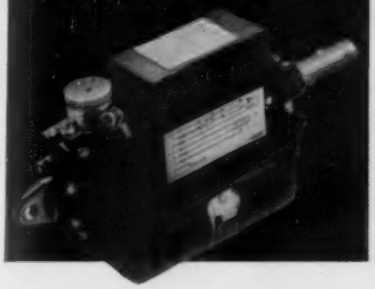
In the Microfilm phase of its Microsystems Electronics program Lockheed is studying vacuum deposition and electron beam techniques for cutting patterns. In its Molecular Electronics phase, it expects to employ both chemical and vacuum deposition processes of the first two program phases and is looking into new semiconducting materials made of refractory materials and capable of operating near 700 or 800C.



Printed Contact Relay Developed

Printed contact relay, for use with printed circuit board, performs switching by means of armature carrying 12 fingers which make or break contact with printed board conductors. Layout of printed circuit board conductors underneath relay armature determines effective relay configuration. Single relay can provide up to three-pole double-throw action or control six individual circuits. Only soldered connection to relay is for its operating coil. Relay measures slightly less than one inch cube, is available with operating voltages of 6, 12 and 24 v.d.c. Maximum ambient temperature is 70C. Manufacturer: Executone, Inc., 47-37 Austell Place, Long Island City 1, N. Y.

COMPACT AiResearch 60 cycle Actuators *for ground use . . .*



Inexpensive, lightweight 60 cycle motor driven actuators with integral magnetic brakes* are now being manufactured by AiResearch for ground radar, ground support and shipboard use.

Unequalled in 60 cycle performance, these extremely compact, lightweight actuators range from fractional hp motor size up to any desired hp in single phase, two phase and three phase design for a wide variety of applications.

The above-pictured actuator is used in a ground radar system. It is driven by a single phase 60 cycle ac fractional hp electric motor and can be furnished with a feedback potentiometer for use in servo applications. The entire unit weighs only 2½ lb. and is rated at 200 lb. operating load.

OTHER ELECTROMECHANICAL COMPONENTS AND SYSTEMS

A C and D C Motors, Generators and Controls • Static Inverters and Converters • Linear and Rotary Actuators • Power Servos • Hoists • Temperature and Positioning Controls • Sensors • Programmers • Missile Launchers • Radar Positioners • Power Supplies • Williamsgrip Connectors

Your inquiries are invited.

* *patented 60 cycle operated magnetic brake*

THE GARRETT CORPORATION

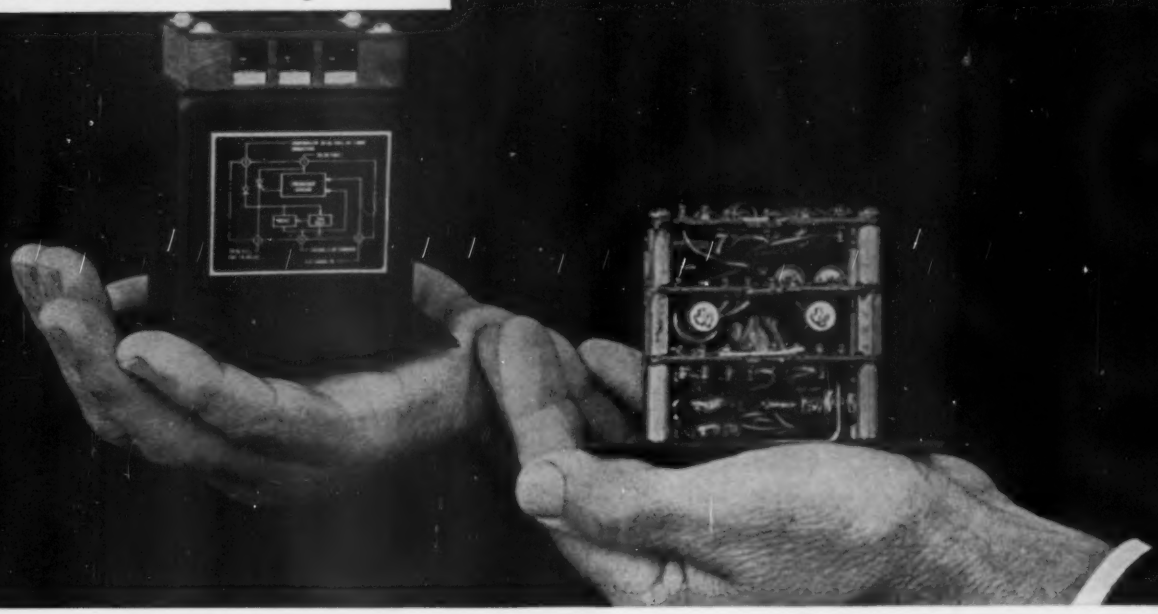
AiResearch Manufacturing Division

Los Angeles 45, California

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

SPECIFIES TI CONTROLLED RECTIFIERS FOR RELIABLE TURBINE OVERSPEED MONITOR



All-diffused TI 2N1595 in TO-5 case provides superior static control

Engineers at the Los Angeles AiResearch Manufacturing Division of the Garrett Corporation designed the Turbine Overspeed Monitor for use in missiles and aircraft. This 12-ounce unit utilizes electromagnetic sensing at 5000 cps for firing TI silicon controlled rectifiers to provide 1 amp of corrective current at 24 volts dc.

To obtain top missile reliability, AiResearch specified TI 2N1595 silicon controlled rectifiers. These all-diffused highly reliable devices provide unique device characteristics, size and weight savings . . . in the more economically priced TO-5 case. TI provided AiResearch with controlled rectifiers featuring guaranteed specifications, tighter leakage tolerances, and consistent stability.

In addition to controlled rectifiers, AiResearch engineers have designed other TI components into such equipment as temperature controls, frequency converters, and frequency monitors . . . applications where maximum reliability is of paramount importance.

Contact your nearest TI sales office for price, delivery, and technical information concerning all reliable TI components.

Remember . . . you can *rely* on TI!

SILICON CONTROLLED RECTIFIERS

Type	At 90°C Case Temp: Av Rect Fwd Current Amps	At 90°C Case Temp: Recurrent Peak Current Amps	Non-Recurrent Surge Current 1 Cycle at 60 cps Amps	Min Fwd Off Voltage* v	PIV	Min Breakdown Voltage v	Max Case Temp °C	Max Fwd Gate Current ma	Gate to Cathode PIV v	max Fwd Voltage Drop @ Avg Rect Fwd Current @ 25°C Stud Temp v @ a	Gate Current Req to Fire ma: Typ	Gate Current Req to Fire ma: Max
2N1600	3	10	25	50	50	60	150	100	5	2 @ 3 amps	1	10
2N1601	3	10	25	100	100	120	150	100	5	2 @ 3 amps	1	10
2N1602	3	10	25	200	200	240	150	100	5	2 @ 3 amps	1	10
2N1603	3	10	25	300	300	360	150	100	5	2 @ 3 amps	1	10
2N1604	3	10	25	400	400	480	150	100	5	2 @ 3 amps	1	10
2N1595	1	3	15	50	50	60	150	100	5	2 @ 1 amp	1	10
2N1596	1	3	15	100	100	120	150	100	5	2 @ 1 amp	1	10
2N1597	1	3	15	200	200	240	150	100	5	2 @ 1 amp	1	10
2N1598	1	3	15	300	300	360	150	100	5	2 @ 1 amp	1	10
2N1599	1	3	15	400	400	480	150	100	5	2 @ 1 amp	1	10
TI-010	1	3	15	50	50	60	150	100	5	See data sheet for switching information		
TI-025	1	3	15	50	50	60	150	100	5			
TI-050	1	3	15	50	50	60	150	100	5			

*Measured with 1K ohm resistor gate to cathode

ANOTHER DIODE/RECTIFIER PRODUCT FROM TI

MOLY/G DIODES (mesa computer, general purpose, reference) • gallium arsenide microwave varactor diodes and tunnel diodes high-voltage diode stacks • controlled rectifiers • high-current/high-voltage rectifiers • epoxy economy rectifiers • special encapsulated circuit functions • resistors and capacitors

SEMICONDUCTOR-COMPONENTS DIVISION

TEXAS INSTRUMENTS

LIMITED — DALLAS ROAD • BEDFORD, ENGLAND

INCORPORATED — 13500 NORTH CENTRAL EXPRESSWAY • DALLAS, TEXAS

Space Vehicle Battery Reliability Probed

Santa Monica, Calif. – Important steps in improving reliability of space power systems will be taken later this month when industry and military representatives meet at the Army Signal Research and Development Laboratory to thrash out problems encountered with sealed nickel cadmium storage batteries.

The meeting, to be held on Oct 18 and 19 (AW Oct. 3, p. 30), is being coordinated jointly by the Power Sources Division of the Army Signal Corps and Air Force Wright Air Development Division. Its immediate purpose is to assemble battery suppliers and space system designers, to learn what the batteries' limitations are, to gather information on battery requirements and testing. From this exchange, it is hoped, battery characteristics can be improved. A large-scale Advanced Research Projects Agency research and development program in nickel cadmium batteries for which funds reportedly have already been allocated is expected to follow before the end of the year.

Preliminary Survey

In a preliminary step, Cook Electric Co., under WADD sponsorship, began surveying storage battery users in an effort to compile a list of battery parameters required by organizations active in space programs. Final results of the survey, however, are not expected to be completed by meeting time.

Nature of the difficulties with nickel cadmium storage batteries, which are the workhorses of power systems in this country's earth satellite and other space systems, were indicated here recently in a panel discussion on the results of solar cell-storage battery systems developed for U.S. space vehicles. The discussion was part of the space power systems conference held under the auspices of the American Rocket Society.

Among the nickel cadmium battery difficulties cited by a panel of project engineers responsible for the design of power systems on past and projected space programs were the following:

- **Temperature limits of paper** separators in the batteries. Safe temperature limits of the separators are about 90 deg.
- **Structural defects and leaks.**
- **Contamination.**
- **Corrosion of electrodes.**

In addition, questions were raised about overcharging the batteries in high satellite orbits or having insufficient time for recharging in low orbits.

Some specific cases were mentioned by the panel: about 20% of the batteries tested at the Applied Physics Laboratory of Johns Hopkins University in connection with the Navy Transit navigation satellite program failed to pass qualification tests, although batteries finally selected for the satellite functioned well. Failure of power supply in the Pioneer V is attributed to the nickel cadmium supplies, it was reported.

Specific Systems

The panel members discussed the power systems of a number of major programs including:

- **Ranger**—Ranger vehicle being developed by Jet Propulsion Laboratory for NASA and to be employed in lunar landings will have two oriented silicon solar cell panels, each of which will deliver 90 watts in space, Robert C. Hamilton, formerly of JPL but now with Hughes, reported. Primary silver zinc batteries will provide power during launch and guidance maneuvers when converter output is inadequate. Silver zinc batteries were chosen over secondary batteries, Hamilton said, to maximize watt-hr./lb. system performance. Manually activated primary silver zinc batteries planned for Ranger shots will deliver about 60-watt-hr./lb. for the required discharge times. The first two Ranger flights, Hamilton said, will carry a 7,000 watt-hr., 120 lb. battery capable of powering the entire spacecraft without any power from the solar cells for more than 35 hr. of the 66-hr. flight time. For the next three Ranger flights the primary battery will be dropped to 35 lb. providing 10 hr. of operation during the 66 hr. flight. A diode power circuit will switch from solar cells to the primary battery. Five functionally separate static inverter regulated power supplies, each short circuit protected, will power communications, attitude control, data and command processing and scientific instruments.
- **Midas and Samos**—These vehicles employ fully oriented solar arrays with 15 x 17 in. panels, according to Charles Burrell, Lockheed Missiles and Space

Power Information Center

To satisfy the growing need for exchange and distribution of information on energy conversion and power systems, the Department of Defense is initiating an ambitious plan for a power information center of the Interservice Group for Flight Vehicle Power.

The University of Pennsylvania, under a $100,000 tri-service contract administered by the U. S. Army Signal Research and Development Laboratory, will establish the center for the Interservice Group (soon to be known as the Inter-Agency Advanced Power Group) to include National Aeronautics and Space Administration and Atomic Energy Commission as well as the military services. Commercial and nonprofit organizations are being invited by the university to report their work to the center for distribution to all government agencies. Proprietary information will be safeguarded, according to the university.

In the first phase of the center's operation, information on government-sponsored work is to be distributed to selected companies in the form of project and status sheets on such topics as electromechanical, electromagnetic, photoelectric, mechanical, thermoelectric and miscellaneous power sources.

Companies which are active in these fields and wish to be placed on the mailing list of the center must apply through the service for which they are working and should specify their area of interest.

The center is expected to be in operation in four or five months, according to an official from the university.

In another effort to exchange data in this field, DOD, acting through the Signal Corps, has set up the Solar Energy Information Center (SEIC) which collects, analyzes and distributes technical information on solar conversion. The SEIC monthly newsletter, which publishes highlights of the field including contract data, conference schedules, etc., is now available on request from the Commanding Officer, U. S. Army Signal Research and Development Laboratory, Ft. Monmouth, N. J.

Contributions to the SEIC newsletter should be sent to Arizona State University, Tempe, Ariz., which is handling the newsletter under a small contract from the Signal Corps.

For some time the services have sponsored the collection and publication of data on power sources in specified research fields. The Army publishes quarterly reports on fuel cells while the Naval Research Laboratory makes available similar quarterly reports on thermoelectricity, the fifth of which was completed recently. USAF has begun a similar effort on thermionic conversion.

Put this RCA Weather Eye on Your Aircraft

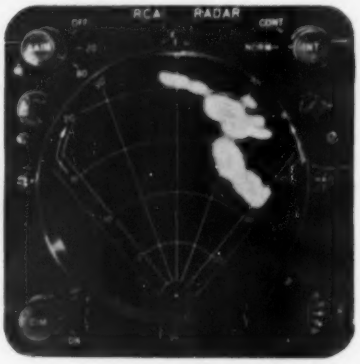
...and "see" the weather miles ahead!

It's the RCA AVQ-50 Weather Radar, specially designed for use in aircraft where weight, space and power are at a premium.

In thousands of installations, the AVQ-50 has cut operating costs of business and executive aircraft, improved on-time arrival and increased passenger comfort. By "seeing" the weather far ahead, your pilot can go around or between turbulent areas and often avoid long and costly detours, greatly increasing the effectiveness and economy of your aircraft.

Because it contributes to safety, as well as improved scheduling and flying comfort, weather radar has been designated as required equipment for most commercial airlines. By making the AVQ-50 lighter, smaller and less costly RCA makes it available to most executive and business aircraft.

For complete information, get in touch with the nearest Authorized RCA Dealer listed on the opposite page, or address: Radio Corporation of America, Aviation Division, 11819 W. Olympic Blvd., Los Angeles 64, California.



RCA®

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

For full information about the RCA WEATHER RADAR get in touch with your nearest RCA authorized dealer listed below.

Aircraft Radio & Accessory Co.
Denver 7, Colorado

Airmar Radio Service, Inc.
Ronkonkoma, N. Y.

AiResearch Aviation Service Co.
Div. of Garrett Corp.
Los Angeles 45, California

Anderson Aircraft Radio Co.
Detroit, Michigan

Associated Radio Co.
Dallas, Texas

Atlantic Aviation Corp.
Wilmington, Del.

Butler Aviation, Inc.
Chicago 66, Illinois

Butler Aviation
Milwaukee 7, Wisc.

Butler Aviation
Washington, D. C.

E. Farnell & Co., Inc.
Palm Beach, Florida

Flightcraft, Inc.
Portland, Oregon

Florida Aviation Corp.
Miami 48, Florida

Gopher Aviation, Inc.
Rochester, Minn.

Minnesota Airmotive
Minneapolis 50, Minn.

Ohio Aviation Company
Dayton, Ohio

Piedmont Aviation, Inc.
Winston-Salem, N. C.

Qualitron, Inc.
Burbank, California

Reading Aviation Service, Inc.
Reading, Pa.

Remmert-Werner, Inc.
St. Louis, Missouri

Robbins Aviation Corp.
Pontiac, Michigan

Roscoe Turner Aeronautical Corp.
Indianapolis 21, Indiana

San Jose Avionics Co.
San Jose, California

Smith-Meeker Eng. Co.
New York 7, N. Y.

Southern Airways Company
Atlanta, Georgia

RCA ®

Standards for Space Solar Cells

Santa Monica—Manufacturers and users of solar cells gathered here during the Space Power Systems Conference to hammer out standards for preparing, selecting, packaging, identifying and measuring the solar cells to be used in space power systems.

Systems manufacturers, many of them contend, encounter difficulties with solar cells largely because of the absence of solar cell specifications which would permit them to predict cell operation in the sun's light in space. In measuring their cells, manufacturers frequently use tungsten light sources, with or without filters, in finding the spectral response of the cells. Accuracy of these measurements is considered to be about 10%. Not knowing the actual solar response of the cells, the engineer may not get the power he expects from his design. To adequately anticipate cell performance, one systems engineer caustically commented, it would be necessary to send a tungsten light into space with the system or bring the sun down to earth.

As an initial step in solving this problem, representatives of a number of organizations agreed to use Johnson's curves, which are a measure of the sun's energy incident on a surface in space, in specifying the performance of solar cells.

Among those participating in this second meeting of the industry-wide solar cell group, loosely sponsored by committees within the American Institute of Electrical Engineers and the Institute of Radio Engineers, were Hughes Aircraft, International Business Machines, Radio Corp. of America, Jet Propulsion Laboratory, Lockheed Aircraft, Hoffman Electronics, International Rectifier, Boeing Airplane, Electro-Optical Systems, General Electric, Johns Hopkins, Optical Coating, Space Technology Laboratories, Spectrolab, Harshaw Chemical, Transitron, Texas Instruments and the U. S. Army Signal Research and Development Laboratory. Chairman of the group is Arvin Smith, Jet Propulsion Laboratory, Pasadena, Calif.

At its previous meeting, four vendors volunteered to supply solar cells for round robin measurements of average spectral responses. Cells supplied by Hoffman, Transitron, Texas Instruments and International Rectifier were checked by Hoffman, Transitron, Electro-Optical, General Electric, Lockheed, Boeing, Texas Instruments and Radio Corp. of America and were found to have widely varying spectral responses, it was reported.

Division. Arrays are folded within the structure during launch and are extended later in a lazy tong manner. Nickel cadmium cells will be used for storage. Rotation will be reversed when the cells are in the earth's shadow.

• **Advent**—This 24-hr. communications satellite will employ two paddles with solar cells distributed over one side of each and will be free to rotate with respect to the vehicle to maintain continuous alignment with the sun (AW Oct. 3, p. 29), Richard Karcher, General Electric Missile and Space Vehicle Department, reported. The vehicle will be flipped once each orbit, Karcher said, to reorient the paddles for the next orbit. Nickel cadmium batteries provide energy storage during the dark period fixed by Advent's orbit at 72 min.

Progress in research and development of later generation solar cells was reported extensively at the conference. The Army announced tests and measurements on the Signal Corps developed P-type silicon solar cell diffused with phosphorous (AW Apr. 4, p. 123) indicating the cell has greater resistance to damage by high energy radiation in space than conventional N-type silicon solar cells doped with boron. The Signal Corps first reported work with the new cell at the Institute of Radio Engineers convention in New York last March and at the time said laboratory efficiencies of the cells were consistently greater than 12%.

Tests on the cell were conducted at RCA Laboratories and supported by National Aeronautics and Space Administration and at Transitron Electronic Corp.

Further tests in the University of California synchro-cyclotron and supervised by Dr. Joseph Denney of Space Technology Laboratories show the new cells to be four times more resistant to proton irradiation than are standard cells, the Army said. Exposure to the same radiation (protons with energy of 740 million electron volts) degrade power output of standard cells.

In a report to the conference on electron bombardment of standard silicon solar cells, R. G. Downing of STL analyzed effects on solar cell efficiencies of exposure to radiation similar to that experienced by satellites. An integrated flux of about 5×10^{15} electrons/cm.^{2} degrades efficiency by about 25%, he said. Experiments and subsequent calculations show that about 65 mils of quartz or glass are necessary for protection of solar cells from 800 kev electrons in the trapped radiation bands, he concluded. Solar panels of the Project Advent communications satellite which may be exposed to sizable accumulated dosages during its three-year lifetime, will be

From THIOKOL's Reaction Motors Division

CRYOGENIC VALVES

to handle all fluids and gases in flight and GSE applications

WORLD's LARGEST FLYING VALVE (11" line size)

- Weighs only 50 lb
- Flows 6600 gpm LOX
- 2.8 psi pressure drop

This disconnect and check valve of extremely high reliability is being used in Project Mercury, America's Man in Space program. It is a modified version of an RMD valve which has flown many successful Atlas missions.

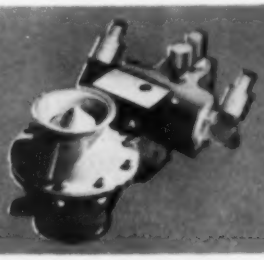
THRUST TERMINATION VALVE

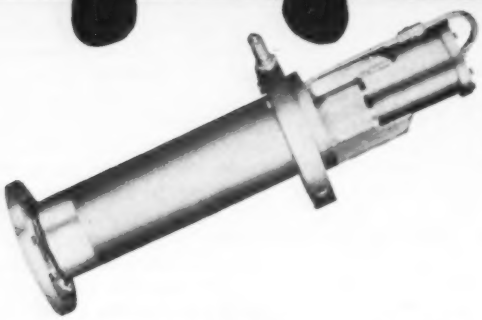
- Extremely high response: 15 milliseconds closure
- Handles liquid hydrogen, boron and other exotic fuels
- Weight: only 4 lb
- Line size: 3 inches (no bigger than section of line it replaces)

No external leakage paths. No dynamic seals. Readily jacketed. Can be used as main propellant valve. As a scram valve for nuclear applications. Thrust termination. Flow measurement. Transient flow limiter.

3" LOX SHUT-OFF VALVE

Was designed, built and flight certified in just 10 weeks from receipt of inquiry. Used in Titan. Low weight poppet type valve assures maximum seal effectivity, minimum leakage. Electro-pneumatic actuation.



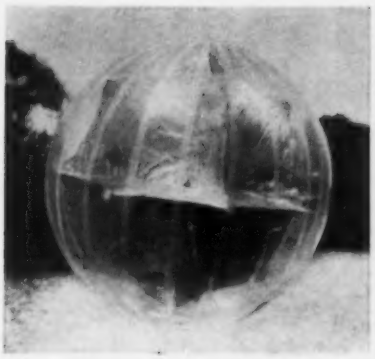


6" LIQUID HYDROGEN TANK SHUT-OFF VALVE

3200 gpm. For shut-off, flow measurement, saturated fluid temperature determination. Readily vacuum jacketed. No shaft. No external leakage passages. Hermetically sealed.

The cryogenic valves shown here underscore another advanced and diversified capability of THIOKOL. For full information, contact Sales Manager, Components Dept.

Thiokol®
CHEMICAL CORPORATION
Reaction Motors Division
Denville, New Jersey



Radar-Tracked Balloon

Balloon one meter in diameter manufactured by G. T. Schjeldahl Co. of Mylar plastic contains a corner reflector for radar tracking. The balloon, designated Robin, was boosted last month by Loki Dart rocket from Holloman AFB, N. M., to about 50 mi. altitude where it was automatically inflated with isopentane. The balloon was tracked by radar down to 40,000 ft. altitude to measure wind drift and other meteorological data.

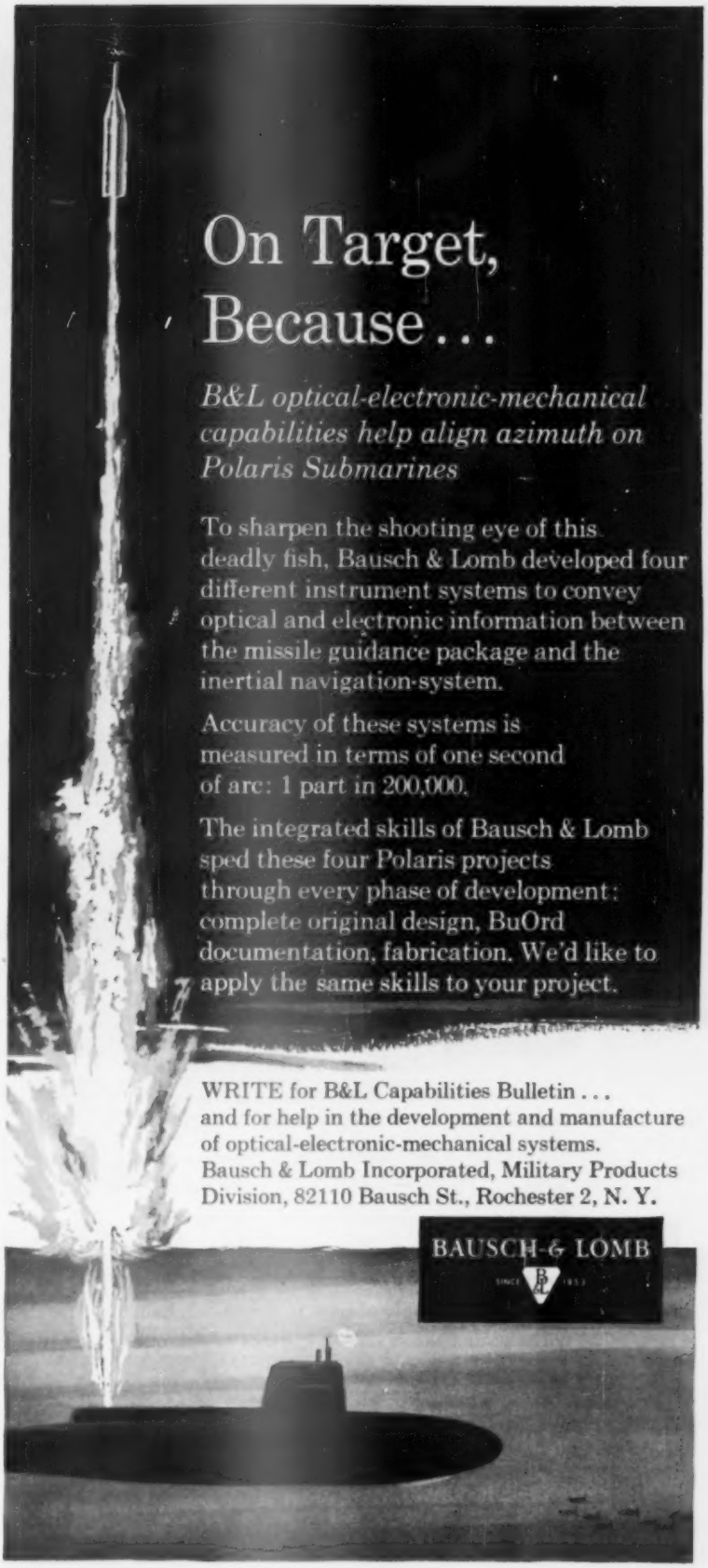
covered by a 70-mil quartz coating.

Research at General Electric with polycrystalline large-area solar cells potentially capable of supplying large amounts of power was outlined in a joint report, delivered by James F. Elliott. The ability to supply large amounts of power with conventional cells at least in part depends on the availability of large single crystals. At General Electric two approaches to large area cells (one square foot compared with the few centimeter squared cells sold commercially) are followed.

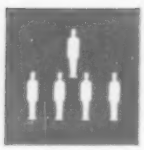
One approach involves thin films which ultimately may offer the desired large area and high watts/unit cost because of the smaller amount of silicon employed. Another approach employs silicon deformed by rolling, extruding, forging, etc. It is hoped that such studies will lead to a drastic reduction in the cost and weight per watt output of solar cells.

Theoretically, polycrystalline solar cells with 5-10% efficiencies and a minimum thickness and grain size of about 10^{-4} to 10^{-3} should be feasible, the GE report said. Thin films appear to be the more attractive solution to large area cells because of potential weight and cost reductions, but the deformation approach is more straightforward and immediate.

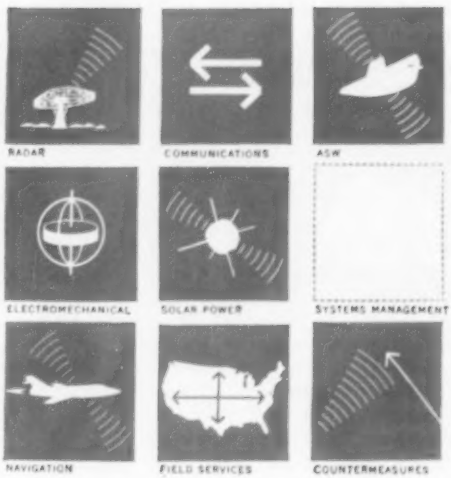
Cells were made by both approaches although efficiencies were not calculated. The General Electric report estimates that successful completion of this program could result in polycrystalline cells which would compare as follows with conventional single crystal cells: Conventional cell—25 to 30 kw./yr., up to


On Target, Because . . .
B&L optical-electronic-mechanical capabilities help align azimuth on Polaris Submarines
To sharpen the shooting eye of this deadly fish, Bausch & Lomb developed four different instrument systems to convey optical and electronic information between the missile guidance package and the inertial navigation-system.
Accuracy of these systems is measured in terms of one second of arc: 1 part in 200,000.
The integrated skills of Bausch & Lomb sped these four Polaris projects through every phase of development: complete original design, BuOrd documentation, fabrication. We'd like to apply the same skills to your project.
WRITE for B&L Capabilities Bulletin . . . and for help in the development and manufacture of optical-electronic-mechanical systems.
Bausch & Lomb Incorporated, Military Products Division, 82110 Bausch St., Rochester 2, N. Y.
BAUSCH & LOMB

systems management problems?



As today's weapons and support systems become more and more complex, the need for teamwork and cooperation among contractors assumes increasing importance. Hoffman, a pioneer in the development of the TEAM concept, has acquired a unique capability in systems management. Hoffman's ability to draw together the specialized talents of several organizations is demonstrated by the success of the eight-company "Tall Tom" Team for the U.S. Air Force—an example of how Hoffman can help solve your systems management problems.



Hoffman / ELECTRONICS CORPORATION

Military Products Division

3740 S. Grand Avenue, Los Angeles 7, California

Significant developments at Hoffman have created positions for scientists and engineers of high calibre. Please address inquiries to Vice President, Engineering.

a megawatt for rolled silicon sheet and thin silicon film; power density of 15 lb./kw. for conventional silicon cells and rolled sheet and 0.8 (not including structural material) for thin film; cost per watt of $55 for conventional silicon cells and rolled silicon sheet compared with 15 cents to $1.00 for thin films. Conversion efficiencies of 15, 5-15 and 5-10% are estimated for conventional cells, rolled silicon and films respectively.

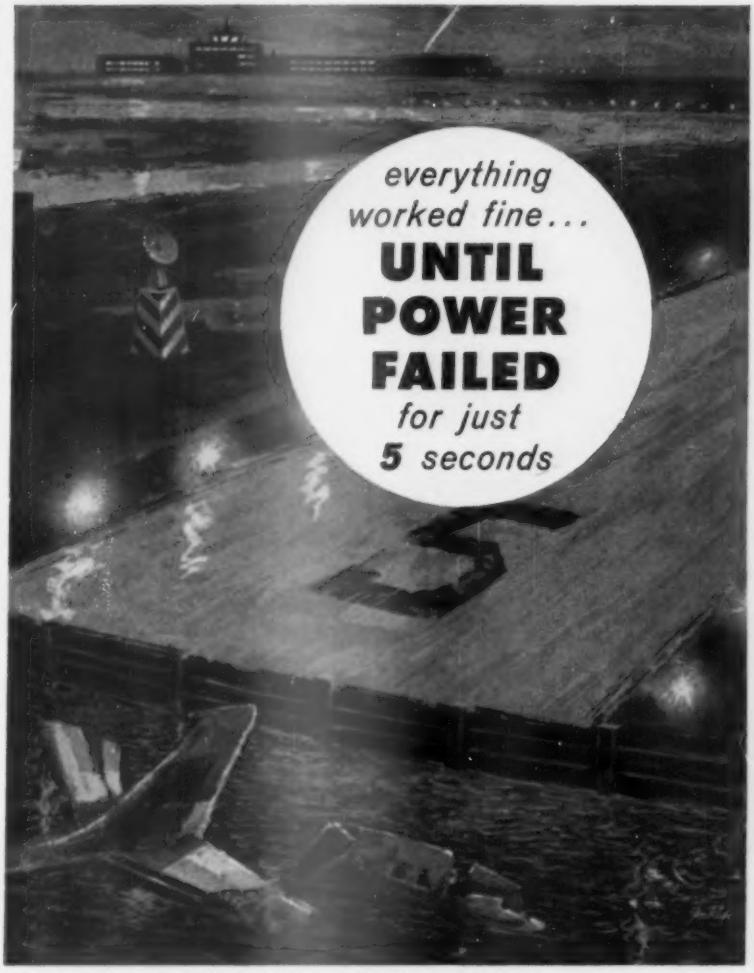
Air Force-sponsored research with solar cells made of thin films of cadmium sulfide which offer potential advantages of weight reduction, and attractive watts/lb. and cost/watt figures were detailed by A. E. Middleton of Harshaw Chemical Co. Although films fabricated to date have not displayed high efficiencies (a 20 sq. cm. active area has 2% efficiency, 3 sq. cm. film 3.8%) the large areas of film solar cells made with economical watts per pound ratios which may be fabricated and exposed to solar radiation might provide power competitive with conventional arrays. Solar converter systems preshaped to the contours of a desired surface might be feasible, Middleton said.

The fabrication of integrally composed variable gap cells prepared by controlled in-diffusion of phosphorous into gallium arsenide cells was the topic of a report delivered by L. E. Stone and coauthored by J. E. Powderly and W. E. Medcalf, all with Eagle-Picher Research Laboratories. Variable gap photovoltaic cells appear to have better conversion efficiencies, open circuit voltages and short circuit currents than single gap cells. A sample of variable cells had an average and maximum efficiencies of 4.69 and 6.9% respectively compared with 2.43 and 4.1% respectively for single gap cells fabricated by the same group.

FILTER CENTER

▶ **WADD to Fund Bionics Effort**—Nearly $1 million is budgeted by Wright Air Development Division's Electronic Technology Laboratory to fund research effort in bionics during current year. Projects of interest include reaction of mathematical models of living functions and development of components, networks and systems capable of performing this function. Interested companies should submit an informal proposal, outlining ideas, to WADD's Electronic Technology Laboratory, Attention: H. V. Noble (WRNE), Dayton, Ohio.

▶ **Centaur Computer Shows Reliability**—First airborne digital computer, built by Librascope for use with Honeywell inertial guidance system in the Centaur,



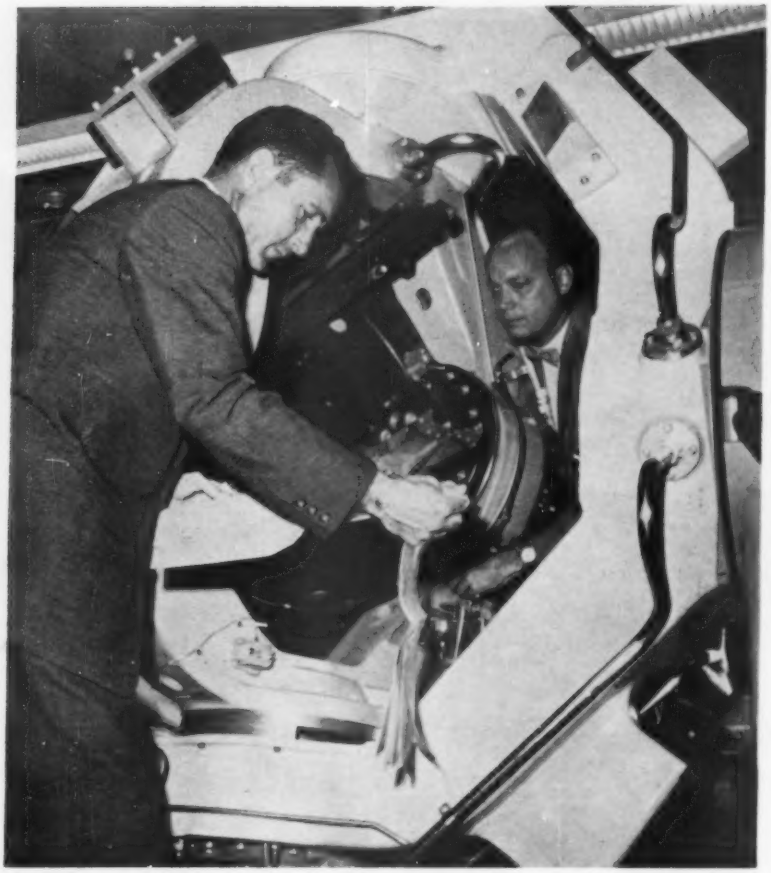
"The approach was normal. The pilot reported over the middle marker. We had radar and voice contact. We were just about to advise him that he was low on the glide path when we suffered a power failure. In five seconds we were back on the air, but there was no target on the scope. There was no answer to our call. There was no plane on the runway."

This could have been an altogether different story if the Condec's Uninterrupted Power Supply had been used for standby power. When prime power fails, **UPS** restores **Full Voltage** in 1.5 **Milliseconds.** Radar contact, voice contact and corrective action could have gone on normally with absolutely **No Power Stoppage.**

Power insurance in the form of these diesel-driven generating units is available in capacities from 10 to 200 kilowatts. The engine turns over only when it's needed . . . operating and maintenance costs are negligible.

Can you afford anything less than this form of standby power for your applications? Demonstrations arranged at our plant.

POWER EQUIPMENT DIVISION
CONSOLIDATED DIESEL ELECTRIC CORPORATION
A Member of The Condec Group
880 CANAL STREET • STAMFORD, CONNECTICUT
15519 LANARK STREET • VAN NUYS, CALIFORNIA



Polaris Launch Stresses Simulated

Polaris guidance and flight control systems are subjected to simulated launch stresses by Lockheed Missile and Space Division's Flight Simulation Laboratory, Sunnyvale, Calif., by a three-axis flight table which simulates roll, pitch and yaw, and an analog computer which mathematically simulates translational degrees of freedom experienced in a launching. Three-axis simulator is shown.

is reported to have operated for nearly 700 hr. without a single failure in bench tests at Honeywell and subsequently at Convair.

▶**Electronics Dictionary Issued**—An 857-page electronics dictionary, which defines and explains meanings of 25,000 technical expressions, has been prepared by Air Force's Research Studies Institute, Maxwell AFB, Ala. Copies of new Air Force Manual 100-39, entitled "Communications-Electronics Terminology, Definitions and Abreviations," dated July 1, 1960, are now available at $3.50 per copy from Superintendent of Documents, U. S. Printing Office, Washington 25, D. C.

▶**Automatic Checkout to Be Evaluated**—Service tests intended to determine whether avionics equipment overhauled and tested with automatic checkout equipment performs better and more reliably than units tested by older manual techniques is being carried out by Arinc Research Corp. under Air Force sponsorship. Total of 75 AN/ARC-27 UHF transceivers, being installed on Strategic Air Command aircraft, will serve as guinea pigs with roughly half of the sets having been tested by automatic checkout equipment, the remainder by manual means. Results of tests will guide Dayton Air Force Depot in assessing value of using automatic checkout equipment in repair and maintenance.

▶**Long-life Tube for Satellites**—New pencil triode, developed by Radio Corporation of America's Electron Tube Division, is expected to have an operating life of more than 25,000 hr. the company says, making it ideally suited for use in satellite payloads. Program was sponsored by Army Signal Research and Development Laboratory.

▶**Facsimile by Meteor Trail**—Complete weather maps have been successfully transmitted over a 900-mi. experimental circuit between Illinois and New York by means of meteor-burst techniques, during the brief lifetime of a single meteor trail. Experimental results indicate that picture keying rates up to 200,000 bits per second can be obtained using a 20 kw. transmitter operating at 50 mc. with rhombic antennas providing 20 db. gain. "Meteorfax" program, carried out by Radio Corporation of America, is sponsored by USAF's Cambridge Research Laboratories (AW June 17, 1957, p. 96).

▶**First BMEWS Station Operational**—Air Force declared the first Ballistic Missile Early Warning System station at Thule, Greenland, operational Oct. 1. Second BMEWS station at Clear, Alaska, is scheduled to become operational next summer.

▶**Weather Stations to Receive Tiros II Cloud Photos**—Eighteen key receiving stations of the U.S. Weather Bureau national high altitude facsimile weather map network and two transmitting stations will be equipped to receive televised cloud cover photos directly from Tiros II satellite. Alden Electronic & Impulse Recording Equipment Co. will adapt scanners and recorders to receive the photos.

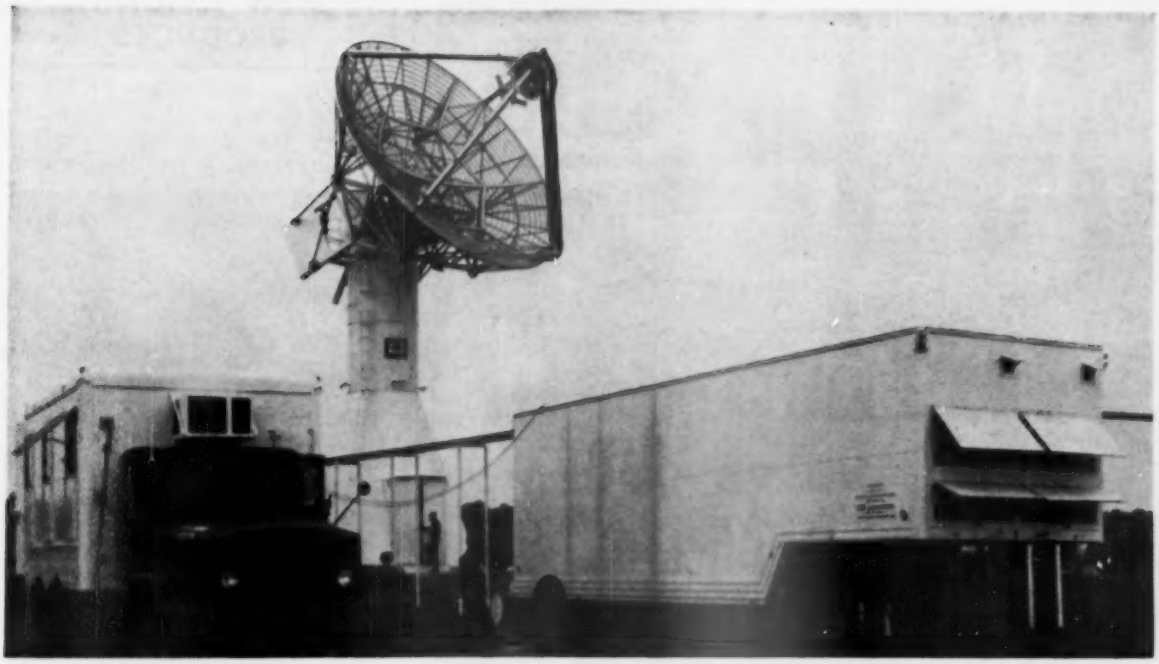
▶**Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **National Research Corp.**, Cambridge, Mass., $52,990 contract for study, experimentation and fabrication of photoemissive devices for solar energy conversion, from Wright Air Development Division.

• **HRB-Singer, Inc.**, State College, Pa., $300,000 contract to supply special airborne electronic countermeasures equipment to quick reaction capability facility at Wright-Patterson AFB, Dayton.

• **Specialty Electronics Development Corp.**, Syosset, N. Y., $1,165,000 award for communication and countermeasures devices and radar test equipment. Included is an Army contract for a 500-watt jammer, which permits two-way communication of friendly forces, housed in shelter on a military truck.

• **Thompson Ramo Wooldridge, Inc.**, two contracts totaling $700,000 from Army Engineering Research & Development Laboratories. Contract includes modification of existing Kelsh Plotters to permit automatic generation of contour lines for preparation of topographic maps, using signal correlation techniques. Second contract covers fully automating the map compilation task, using small digital computer to create mathematical-physical model of the stereographic projections on which the elevation values can be measured. Work will be carried out by TRW's Inteilectronics Laboratories.



Ground Station Communicates With Courier Satellite

Signals from Courier delayed-repeater satellite (AW Oct. 10, p. 29) are received at this ground communications station, developed for U. S. Army Signal Corps by International Telephone & Telegraph Corp. Above is antenna which serves for both acquisition and tracking of Courier and communicating with it (AW Aug. 29, p. 75). Below is interior of the nearby control van. Console in foreground is a switching and data processing center which monitors, controls electronic functions of satellite, ground unit.

THE A. W. HAYDON COMPANY

MIRROR IMAGE ON BOTH COASTS

EAST ELECTRICAL TIMING DEVICES
WATERBURY, CONNECTICUT

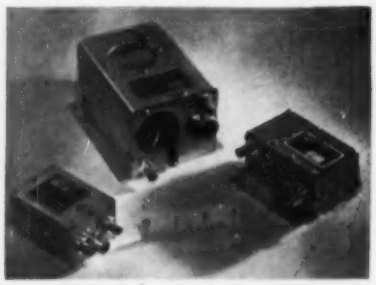
ELECTRONIC TIMING DEVICES WEST
CULVER CITY, CALIFORNIA

Have it your way: electronic or electro-mechanical timing devices and test equipment. ■ The A. W. Haydon Company will design and manufacture either type...or both...to your rigid specifications. And with the same precision, compactness and high reliability as always. ■ For electro-mechanical devices call on our timing specialists at Waterbury, Conn. If your requirements are electronic, our Culver City, Calif. plant can meet your needs. ■ On either coast...on both coasts...there's only one A. W. Haydon.

THE A. W. HAYDON COMPANY

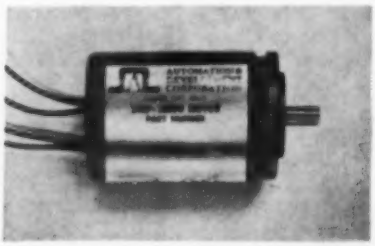
NEW AVIONIC PRODUCTS

• **Power amplifiers,** Models PA-10, 11 and 14, for use in 215 to 260 mc. telemetry range. Model PA-10 provides 10 watts output, measures 2 in. x 1.56



in. x 3 in. and weighs 9 oz. Model PA-11 delivers 10 to 25 watts while Model PA-14 can deliver 100 watts. United Electrodynamics, Inc., 200 Allendale Road, Pasadena, Calif.

• **Servomechanism components** for automatic control applications including step servo motors and companion transistorized controllers, pulse generator and d.c. power supply. Step servo motor (shown) operates bi-directionally on



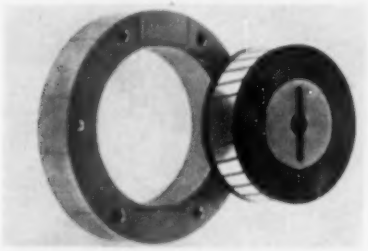
d.c. voltages switched by a logic controller at a desired stepping rate. Controllers and motors can be operated as analog-to-digital or digital-to-analog converters. Automation Development Corp., 11824 Jefferson Blvd., Culver City, Calif.

• **Recording paper** for use in multitude of applications including xy, xyz, depth, event and facsimile recorders and multi-stylus operations. The Timemark recording paper is capable of handling high writing speeds because of its low voltage and stylus pressure requirements. Westrex Corp., 540 West 58th St., New York 19, N. Y.

• **Digital voltmeters-ratiometers,** four-digit V34A and five-digit V35A, include print control to permit printing varying input signals, isolation of signal ground from chassis ground for signals which are floating up to 300 volts above chassis ground, remote a.c./d.c. switchover, increased input impedance in ratio measurements and front-rear input connections. Both meters have

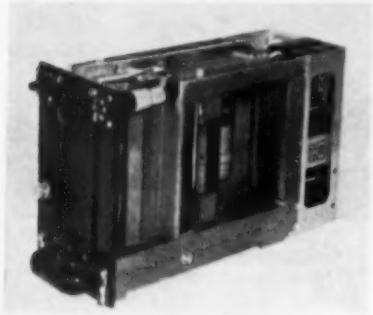
transistorized "needless nine" logic employed in company's previous series 30 meters. Meters measure d.c. voltage from ± 100 microvolts to ± 1,000 volts and d.c. voltage ratios from ± 0.01% to ± 99.999%. Accuracy on the former is ± 0.01% on the former, ± 0.005 to 0.01% on latter. Non-Linear Systems, Inc., Del Mar, Calif.

• **D. C. torque motors,** pancake, multipole, permanent-magnet types for use as high-performance torquers or direct drive servo motors feature 2.2. in.-oz. of torque per watt (for one motor measuring 3¾ in. outside diam., 1⅞ in. inside diam. by 1 in. thick) and 0.35 in.-oz. (for motor 1⅝ in. o.d. by ½ in. thick). The two indicated units pro-



duce peak torque of 165 in. oz. and 20 in.-oz., respectively. Smaller motor, modified for higher speed operation, requires 0.034 watt of starting power and has life in excess of 200 million revolutions. Giannini Controls Corp., 1600 S. Mountain Ave., Durate, Calif.

• **Flight data recorder,** Model F-542, designed for 2,500 hr. of continuous operation, weighs 14 lb., occupies ¼ cu. ft. Dimensions are 4⅞ in. x 7⅞ in. x 12 9/16 in. and power consumption is 20 watts. Model can record for up to 800 hr. of operation (400 hr. at a time)



or for 400 hr. on both sides of foil recording medium simultaneously by the addition of a building block subassembly in space reserved in the assembly for it. Model meets Air, Inc., 542 requirements. United Data Control, 380 N. Halstead St., Pasadena, Calif.

• **Digital signal simulator,** ESS-500, for PCM systems in the laboratory or in the field simulates digital output of air-

These are men you should know

DELAVAN FUEL INJECTOR SPECIALISTS

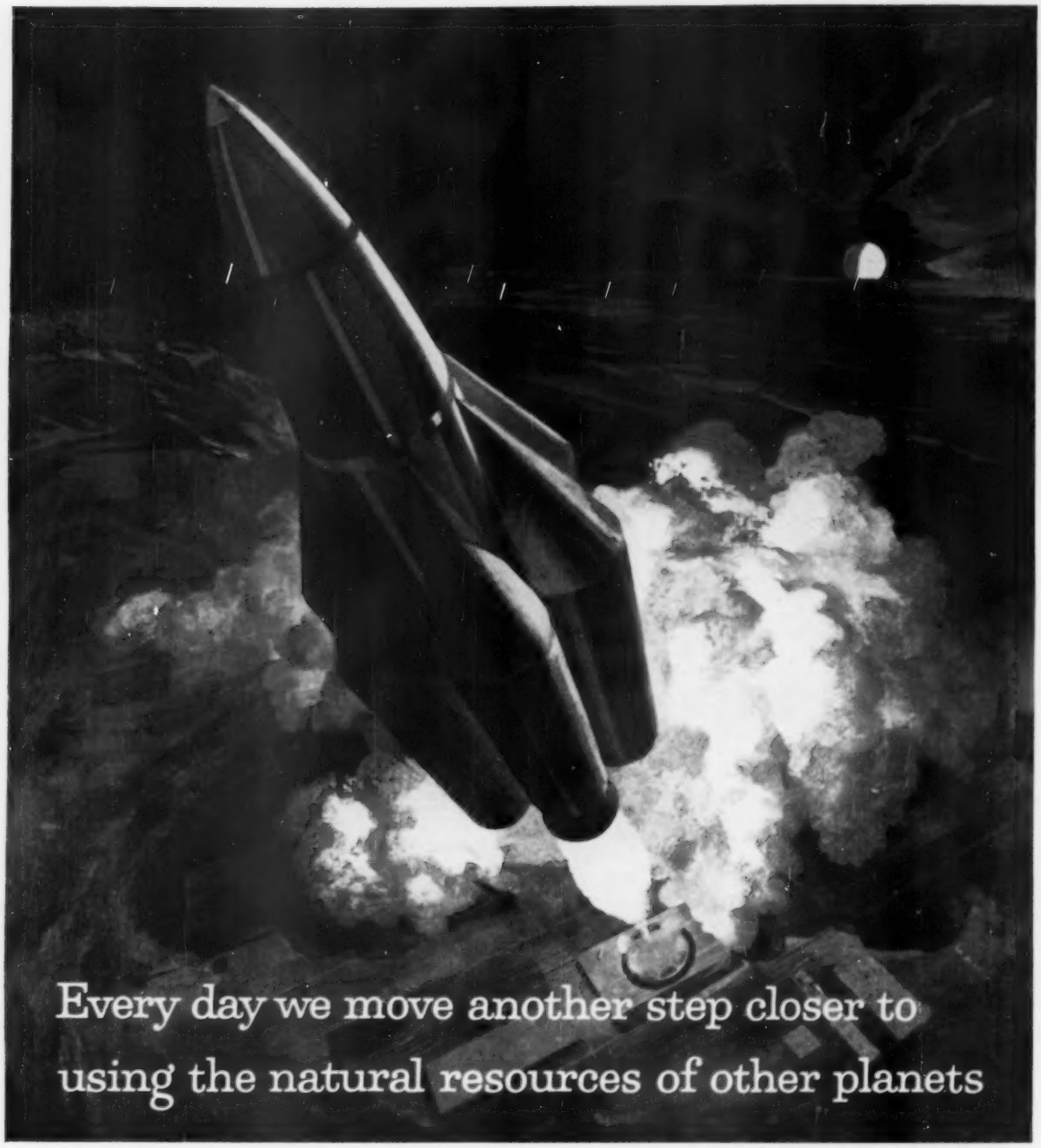
Their names are Robert Freed and John Esbensen. They're Delavan Fuel Injector Sales Engineers. Both are fully qualified to discuss the technical aspects of fuel injector application. Bob Freed holds an E.E. from Kansas State U. and has had six years of jet engine experience. John Esbensen has a B.S. in General Engineering from Iowa State University and over eight years experience as a sales engineer. These men are ready to come to you. They and the staff of project engineers and production specialists at Delavan are the main reasons leading turbo-jet, rocket and APU manufacturers rely on Delavan for fuel injection problem solving.

If fluid metering and atomization are part of your product, take advantage of Delavan's specialized experience and proven ability to deliver aircraft quality at high production rates. Send specifications to the address below for obligation-free recommendations.

DELAVAN

DELAVAN Manufacturing Company

WEST DES MOINES, IOWA



Development of nuclear power, utilized in space ships like this Douglas concept, will speed the day when man will travel in outer space and use its resources.

Air Force space studies aimed at cracking military problems also reveal potential civilian benefits

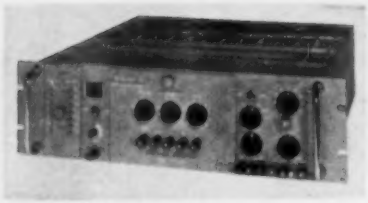
Progress in space research is so rapid that consideration must now be given to projects you'd have scoffed at a few years ago. For instance, development of a nuclear rocket could drop payload costs so low that it would be economically worthwhile to import rare materials from other planets.

Projects such as this are the daily fare of engineers at Douglas. Right now they are studying the many problems related to interplanetary exploration: Can humans survive? What about temperature, gravity, water, food . . . and fuel for the return trip?

Douglas has been finding answers to such problems since 1941. These answers are seen in action every time a Douglas-built Thor boosts another payload into space.

DOUGLAS

MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • TRANSPORT AIRCRAFT • AIRCOMB® • GROUND SUPPORT EQUIPMENT •

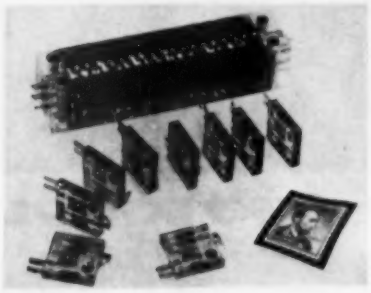


borne or ground multiplexer and digitizer for calibration and checkout. Controls permit selection of word length, frame rate and length, operating frequency and frame position for master sync and fixed data words. Interchangeable coding modules which plug in flush with the front panel enable simulator to generate binary, bcd, excess 3, biquinary, hexidecimal and 1224. Completely transistorized unit occupies 5¼ in. on the standard 19-in. relay rack. Telemetrics, Inc., 12927 S. Budlong Ave., Gardena, Calif.

• **High temperature antennas,** for operation at temperatures as high as 2,000F and shock environments as high as 60g, are available over frequency range of

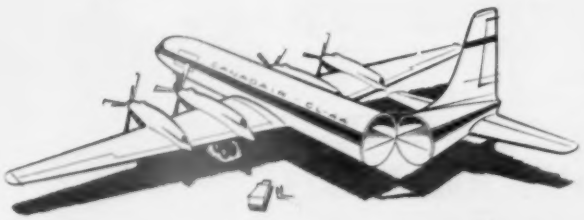
1.3 to 14 kmc. The high-gain dielectric rod antennas, with thin aerodynamic cross-section, have end-fire radiation characteristics. Manufacturer: Don-Lan Electronics, Inc., 1131 Olympic Blvd., Santa Monica, Calif.

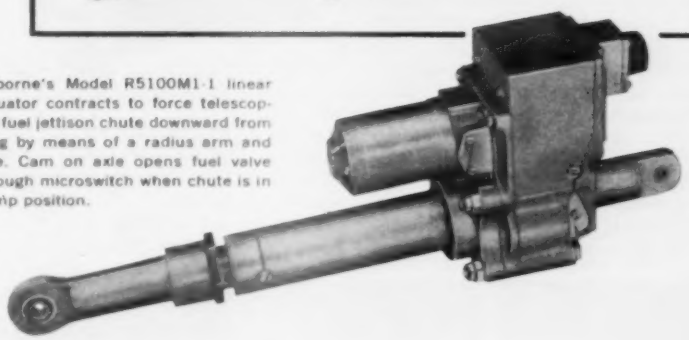
• **Magnetic shift register elements,** in encapsulated postage-stamp size packages, each capable of storing one bit



AIRBORNE ACTUATORS

POWER FUEL JETTISON CHUTES ON NEW Canadair Forty Four CARGO CARRIERS





Airborne's Model R5100M1-1 linear actuator contracts to force telescoping fuel jettison chute downward from wing by means of a radius arm and axle. Cam on axle opens fuel valve through microswitch when chute is in dump position.

Linear actuators by Airborne help provide safe, dependable automatic fuel jettison facilities for Canadair's new Forty Four tail-loading cargo planes. To get rid of excess fuel during flight, all the pilot need do is flick a switch. The Airborne units automatically take over, lower telescoping fuel jettison chutes below the wings, and initiate dumping.

These actuators weigh only 4.5 lb. and contain a 26 volt d-c split field, series wound, reversible motor and a radio noise filter effective up to 150 mc. They allow a duty cycle of .4 minute on 30 minutes off and will take a maximum operating load of 2200 lb. Yet they will operate at only 14 volts under a load of 750 lb. and have an estimated life of 3000 cycles at rated load and duty cycle.

This is an example of how Airborne actuators are relied on by designers for vital safety functions in modern missiles and aircraft. Whatever your design problem, we can help you solve it. Where your requirements are not unique, we provide a line of modular type actuators, both linear and rotary, that will simplify design, production and delivery. Or we can build actuators to your specifications to do the job safely and dependably. Just give us the facts on your particular need and we will promptly submit a proposal. Contact any of our offices for further information.

AIRBORNE®

Engineered Equipment for Aircraft and Industry

AIRBORNE ACCESSORIES CORPORATION

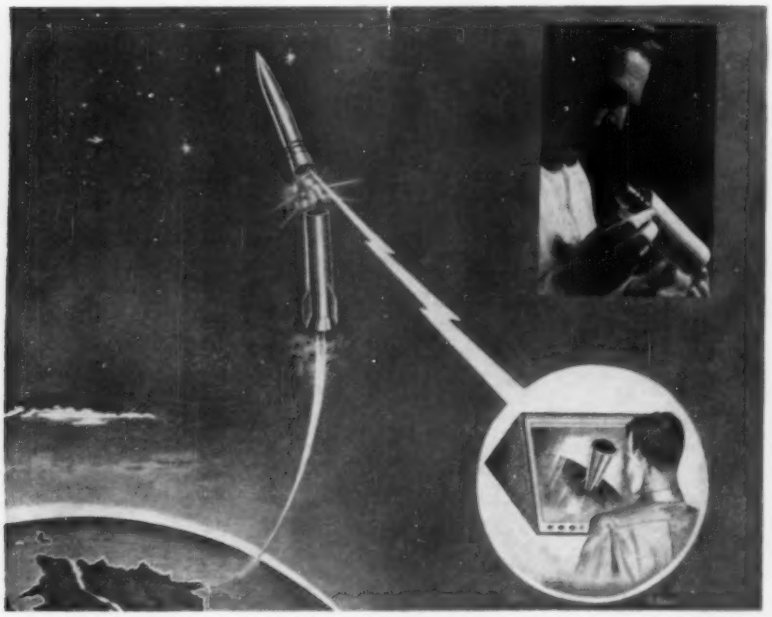
HILLSIDE 5, NEW JERSEY • Offices in Los Angeles and Dallas

can be assembled in modules with up to 10 elements per inch. Representative serial-driven gated transfer element operates at 100 kc. information rate, requires peak shift pulse power of 0.1 watt. Units operating at 500 kc. are under design. Manufacturer: General Electric, Heavy Military Electronics Dept., Syracuse, N. Y.

• **Automatic recording thermobalance** performs thermogravimetric studies in vacuum or controlled atmospheres to temperatures of 1,000C, recording changes in weight as a function of temperature programed for selected linear heating rate or as function of time at constant temperature. Thermogravimetric curves obtained for given compound show weight changes which result from rupture and/or formation of physical and chemical bonds at elevated temperatures. Bulletin 2328 and Reprint 119 give application data. Manufacturer: American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.

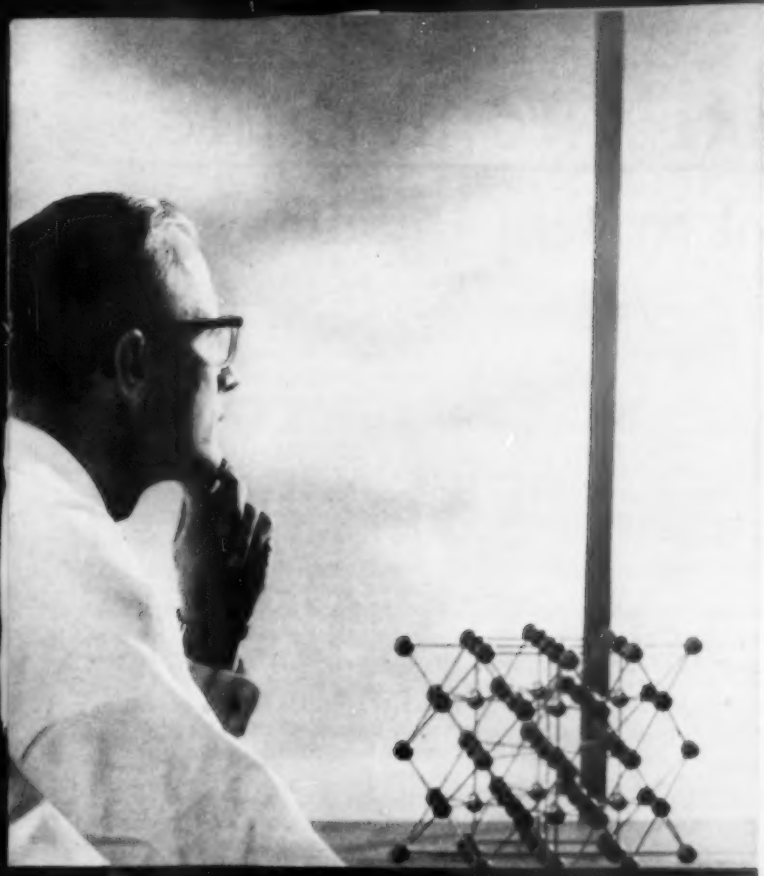
• **Electromagnetic radiation meter.** Model B86L1, lightweight portable instrument for measuring radiation hazard to personnel working near high-power radar/radio transmitters, reads power density direction over frequency range of 400 to 3,000 mc. Device has four power density scales, with full scale

values of 0.02 to 20 mw./sq. cm. Meter weighs 5 lb., measures approximately 8½ x 7¼ x 7 in. Device, produced by Sperry Microwave Electronics Co., is being marketed by Filtron Co., 131-15 Fowler Ave., Flushing, N. Y.



TV Camera Photographs Missile Components

Lockheed Electronics Co., of Plainfield, N. J., has developed a space vehicle or missile-mounted television camera which will allow engineers to view internal components during the weapon's flight. Cameras can be mounted both inside and on the outer shell and are designed to withstand speeds up to Mach 18. Functioning of the vehicle and its internal components are shown on a ground monitor and simultaneously photographed on motion-picture film for later evaluation and for a permanent visual record of the flight. Artist's conception shows how the camera would transmit a picture of stage separation of a space vehicle to the ground monitor. Inset shows an engineer holding the actual camera, which is about the size of a milk bottle and which utilizes a standard 16 mm. motion picture lens. Device has been designated Video Telemetering Camera System (VTCS). Company says system could be used in test flights preceding a manned space vehicle shot.



HEAD IN THE CLOUDS & FEET ON THE GROUND

DOWN-TO-EARTH cost orientation at Motorola begins with disciplined research applied to *creative ideas* and, progressively, pervades every stage of development, assembly, and final production. Ultimately it is reflected in lower field maintenance and support costs consistent with the desired level of reliable performance. This acute awareness of *total* cost versus initial cost, sharpened by more than thirty years of competitive experience and commercial success, is characteristic of Motorola's complete military electronics capability in terms of systems, equipment, and Solid State components.

Because of its demonstrated capability, Motorola is engaged in many complex and advanced programs. For example:

- Military Communication Systems & Equipment
- Data Transmission, Processing & Display Programs
- Missile Systems, Electronics & Instrumentation
- Electronic Warfare & Countermeasures Programs
- Anti-Submarine Warfare Systems & Equipment
- Applied Research & Development in Microelectronics
- Advanced Radar & Sensor Developments
- Solid State Developments in Materials & Devices
- Navigation Systems & Equipment
- Surveillance Systems

More detailed information is available in a comprehensive brochure.

Experienced scientific personnel seeking opportunities to advance in these fields are invited to contact the Motorola office in the location of their choice.

Military Electronics Division

CHICAGO 51, ILLINOIS
1450 NORTH CICERO AVENUE
SCOTTSDALE, ARIZONA
8201 EAST McDOWELL ROAD
RIVERSIDE, CALIFORNIA
8330 INDIANA AVENUE

Short SC.1 Control System Detailed

Flying Britain's Short SC.1. VTOL research vehicle requires a combination of helicopter and fixed-wing techniques, plus one or two techniques that are unique to this aircraft.

• **Like the helicopter,** vertical flight is controlled by the pilot's left hand using a power lever similar to the collective-pitch control for a helicopter.

• **Like the fixed-wing plane,** aircraft trim and attitude are controlled by a conventional pistol-grip stick in the center of the cockpit.

• **Unique to the SC.1,** transition mechanisms have been developed for powered flight between the vertical-rising and the horizontal phases. Also unique is the twist-grip throttle on the lift-engine control, which changes the power on the propulsion engine. A conventional third throttle is fitted on the left side of the cockpit for the wing-borne phase of flight.

Design Function

These control characteristics and the unusual flying qualities of the Short research vehicle trace their roots to the basic layout of the VTOL craft. It was built to test one configuration of the jet lift concept and was designed around a battery of four Rolls-Royce RB.108 lifting engines with a fifth RB.108 engine used for forward propulsion.

The delta-wing geometry of the plane was chosen as the best available compromise between a shape of known characteristics and a possible future configuration for a jet-lift aircraft.

The fundamental needs over and above lift and propulsion were for a control system that would maneuver the aircraft through its entire speed range from hovering to maximum, and a stability-augumenting system for the low-speed end of the velocity bracket.

With these basic parameters to define the task, Short's engineering teams designed and developed the SC.1 vehicle (AW Oct. 12, 1959, p. 84 and Sept. 26, p. 64).

Tilted Thrust

The four RB.108s are installed in the fuselage bay in pairs, each pair trunnion-mounted to tilt in the fore-and-aft plane between 30 deg. forward and 30 deg. aft of the vertical. All four engines are tilted by a hydraulic jack to positions selected by pushbuttons in the cockpit. There is an emergency system so that if the main system fails during tilting, the engines return to vertical if they were between the forward position and vertical, or tilt full aft if they were between vertical and aft.

The control system is conventional for the wing-borne portion of the flight, using a manual push-pull system throughout except for the elevator which is powered to guarantee irreversibility during vertical flight. Reaction control system is used for the low-speed and hovering regimes working on air bled from the compressors and fed through a ring manifold to pitch nozzles in the fuselage and roll nozzles in wings. Stability augmentation system works on only the pitch and roll axes, leaving the pilot responsible for yaw control. He can choose one of three modes of operation for the system:

• **Servo manual,** where the control moment is proportional to the stick displacement.

• **Rate-automatic,** where the control moment is a function of the sum of stick displacement and the rate of change of aircraft attitude.

• **Full-automatic,** where control moment is a function of the stick displacement plus the sum of the rate of attitude change and the attitude itself.

The system is triplicated completely from mechanical movement of the control stick right down to the mechanical output of the servo motor. It has a fault detection system which is based on output comparison of the three lanes of the stability augmenter. If there is a difference of more than a predetermined amount, the fault indicator lights in the cockpit, and an audible warning sounds.

Transition Mechanisms

Normal operation of the SC.1 during hovering and low-speed flight depends on the auto-stabilizing system. But in the event of failure of any portion of that system, it must be possible for the pilot to override and take control. In addition, there are modes of flight in the transition phase where the pilot controls the aerodynamic surfaces and the automatic system operates the reaction controls.

All these combinations of operational modes are handled by the transition mechanisms, subsystems built into automatic control of the SC.1, one each on the pitch and roll axes.

An unusual cockpit layout was planned to handle these various controls and to give visibility comparable to that from a helicopter bubble. The usual pistol-grip stick is in the center

P.1B Uses Glass Fiber Rocket Pods

Retractable glass fiber rocket packs, developed for English Electric P.1B Lightning jet fighter, holds 48 2-in. rockets which can be fired in a single salvo, or in sequence.

French Test Fouga 175 Trainer on Carrier

French Fouga C.M. 175 Zephyr naval trainer makes a carrier landing. The aircraft, powered by two Turbomeca Marbore IIB turbojets rated at 880 lb. thrust each, is a Magister trainer modified for carrier catapult takeoffs and arrested landings.

of the cockpit and rudder pedals are also conventionally fitted. Engine controls are on the port side and automatic control system on the starboard in console mountings.

A lift lever on the left side controls the lift engine thrust, increasing the thrust when the pilot pulls up on the lever. A twist grip on the end of the lever controls the propulsion engine throttle, so that both vertical and forward speeds are controlled by the pilot's left hand.

A third throttle is located in the usual place near the left arm rest for use when the pilot is flying the Short SC.1 fully wing-borne, using the stick to control attitude and the throttle to control altitude as is conventional.

Pilot Routine

After completing the prestart checklist, the pilot starts the single RB.108 propulsion engine and runs it up to check operation of its compressor bleed. He opens the intake gills and increases power on the propulsion engine to almost its maximum tailpipe temperature. Then air is bled from the propulsion engine and used to spin up the four lift engines to starting speed. The pilot flips the ignition switch on and then opens switches for the four high-pressure fuel valves. The engines start simultaneously.

By lifting up on the left-hand lever—analogous to the collective-pitch control in a helicopter—the pilot opens the throttles of the lifting engines and the airplane rises off the ground. At about 50 ft., upward motion is retarded and the pilot checks emergency warning indicators.

Transition starts by tilting the engines to the accelerate position, initiated by push-buttons in the cockpit. As the SC.1 begins to move forward, the pilot uses the left-hand twist-grip throttle to increase power of the propulsion engine. During speed buildup, the airplane gets tail-heavy and needs trimming to a slightly nose-down attitude. As speed further builds up above 75 kt., the aerodynamic controls begin to take over from the reaction system, and the SC.1 becomes more sensitive in pitch and yaw.

About 20 sec. after tilting the engines, the plane reaches 160 kt. airspeed and is fully wing-borne. The pilot switches the auto-stabilization system to non-automatic mode, reduces lifting engine speed to idling and trims the SC.1 slightly nose-up.

He then shuts off the fuel to the lift engines and closes the intake gills. Transition is complete.

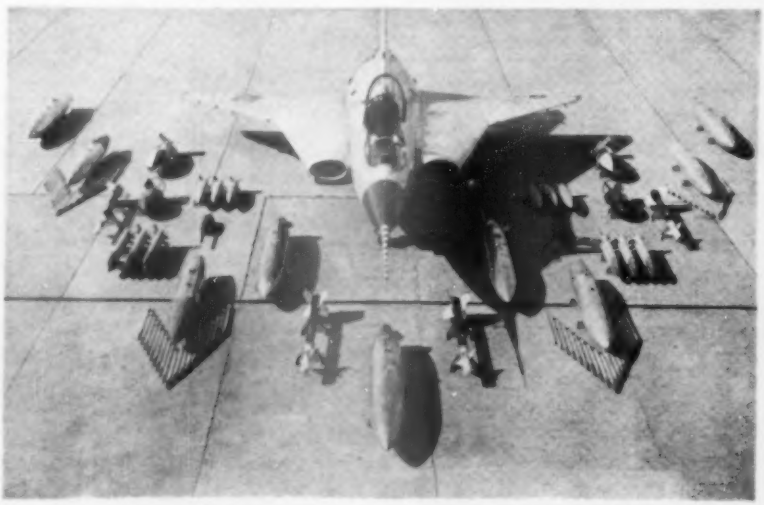
Down to the Ground

Transition back to vertical flight begins on the downwind leg when the pilot checks the tilt of the lift engines by cycling through to full accelerate position and back to normal. He increases power on the propulsion engine and goes through the same starting cycle as if he were on the ground. When the four RB.108 lift engines light up, there is a nose-up change in longitudinal trim which he compensates with the electric trim switch mounted on the control stick. Lift engine starting air is turned off, and autostabilizing system is put into rate-automatic mode of operation.

Final check consists of moving the stick fully in pitch and roll to check functioning of the nozzles in the reaction control system, and then checking the stabilizer fault-detection system.

During final turn-in, the pilot reduces altitude and checks the lift engines with a short burst at full power. On final approach, he lowers the speed to 140 kt. and cuts the propulsion engine to idling about one and one-half miles from the threshold. As speed is killed off, he maintains altitude first by changes in airplane attitude, and then by increase of power on the lift engines.

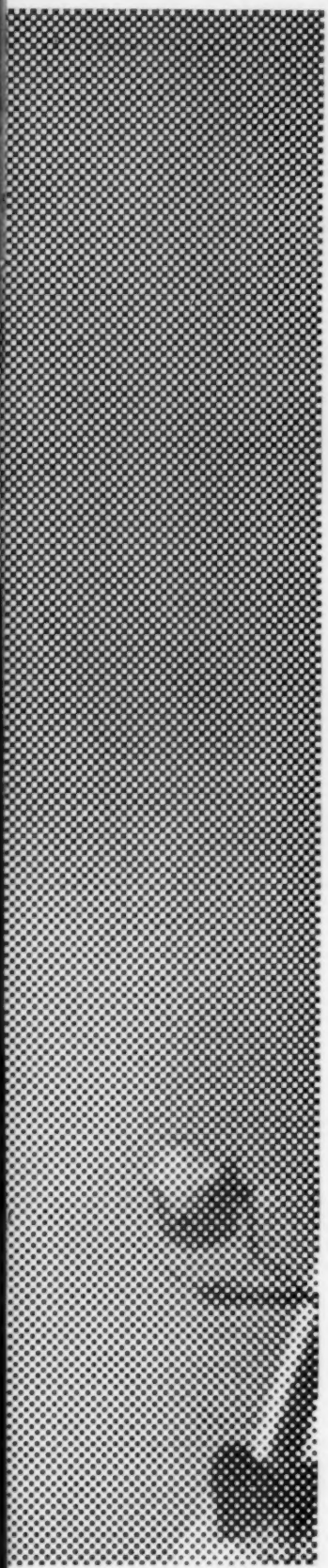
As the speed drops further, he de-



Saab J35 Draken Armament Displayed

Saab J35 Draken jet fighter armament and auxiliary equipment is grouped around the airplane in this photo. From left are an under-wing drop tank, a rocket pod containing 19 7.5 cm. air-to-air rockets, a Sidewinder air-to-air missile, a 1,000 lb. bomb, a 500 lb. bomb, six 13.5 cm. air-to-surface rockets, three 160 lb. flash bombs, a 30 mm. automatic cannon, an air-to-air rocket pod, an under-wing drop tank, another Sidewinder and a ventral drop tank.

Computer-listed master catalog of engine parts reduces production lead time at Rocketdyne.



Keeping the cost of space down to earth

Behind the thundering performance of Rocketdyne's engines, a significant reduction in the cost of power for America's missiles has been quietly achieved. Today, Rocketdyne engineering skill and efficient production methods make it possible to power two missiles for the cost of one in 1957.

Rocketdyne, the pioneer in rocket science, was first with power for America's long range ballistic missiles—first with power for outer space. In establishing this technological leadership, Rocketdyne developed new management concepts at every level of operation, from early design through final testing. The result is outstanding technical achievement at the lowest possible cost.

In data processing alone, advanced techniques are saving engineers hundreds of hours of experimentation and testing and have contributed to a 37 percent reduction in Atlas engine costs for the Air Force. An intracompany communications network links test stands and research laboratories in Missouri, Texas and California; gives management the daily status of every program—whether it's on schedule, what parts are in short supply, how the production line is performing.

Through research, engineering, and management, Rocketdyne is constantly at work not only to increase thrust performance and develop new propulsion techniques, but at the same time to reduce costs all along the line.

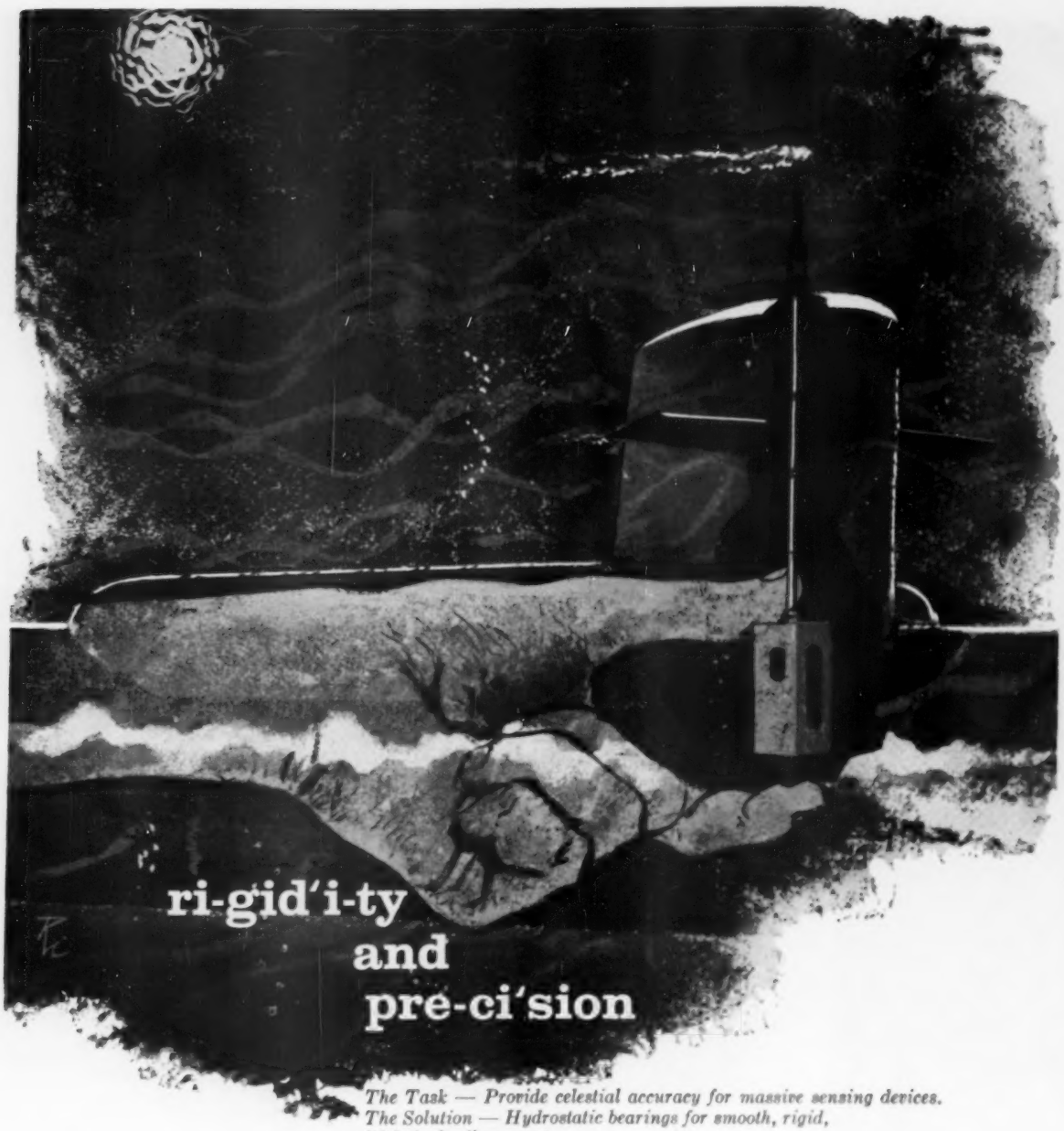
25 of America's 28 successful satellites and space probes have been launched by Rocketdyne engines.

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

DIVISION OF NORTH AMERICAN AVIATION

Canoga Park, California; Neosho, Missouri; McGregor, Texas



The Task — Provide celestial accuracy for massive sensing devices. The Solution — Hydrostatic bearings for smooth, rigid, "frictionless" support.

In Polaris submarines and other military applications, these hydrostatic bearings, developed by Nortronics, are particularly suited to virtually frictionless support of a large structure, which can be positioned accurately by a servo system with no unevenness, runout or binding — yet extremely stiff under applied loads.

A NOTE FOR TALENTED ENGINEERS:
We invite your inquiry as to important positions at Nortronics' Precision Products Department. Excellent salaries for qualified men in both our Systems and Component Groups.

Contact E. P. Reardon

NORTRONICS
A Division of
NORTHROP CORPORATION

PRECISION PRODUCTS DEPARTMENT
NORWOOD, MASSACHUSETTS
Field Offices

Highway #46
Teterboro, New Jersey
Telephone: ATlas 8-1750
TWX-Hasbrouck Heights 871-U

2486 Huntington Drive
San Marino, California
Telephone: ATlantic 7-0461
TWX-Alhambra 9619-U

Rohr Delivers Boeing B-52H Struts

Wing struts for the first Boeing B-52H jet bomber are inspected during unloading operations at Boeing's Wichita, Kan., Division, where the plane is under construction. Units were built by Rohr Aircraft Corp.; each of the four struts will support two Pratt & Whitney JT3D turbofan engines.

creases the tilt on the engines and increases the thrust of the lift engines by hauling up on the left-hand lift control. By increasing thrust on the lift engines and decreasing the tilt, the SC.1 can be brought to a hovering standstill in the air above the chosen landing spot. Then the pilot simply backs off on the lift engine power and eases the plane onto the ground.

New Funds Awarded For Hydrofoil Boat

Washington—Dynamic Developments, Inc., an affiliate of Grumman Aircraft Eng'g. Corp., has a $428,000 contract from the Maritime Administration to build a set of super cavitating hydrofoils for use on the 90-ton aluminum hydrofoil boat the company is scheduled to launch next June.

The completely submerged supercavitating foils will give the 90-ton boat a top speed of about 100 kt., compared with approximately 60 kt. using the surface-piercing, subcavitating foil system being constructed under the original $1.5 million fixed cost Maritime Administration contract for the boat that was awarded early this year. The new contract is cost plus fixed fee and subject to adjustment.

The Grumman boat is powered by a modified General Electric J79 turbojet and it will be the first large, turbine-powered, seagoing hydrofoil using lightweight construction similar to that used in seaplanes. Maritime Administration expects the boat to prove the economic attractiveness of this type design in sea trials next summer.

U-2s Assigned To Australia

Canberra, Australia—Trio of Lockheed U-2 high-altitude reconnaisance aircraft will operate here next month as part of a fleet of more than 20 U. S. aircraft in a program of upper-atmosphere sampling.

Australian Defense Minister Athol Townley said the sampling program will check nuclear fallout and radioactivity in the upper atmosphere in the region between 40 and 50 deg. south latitude.

Flights are part of a program operated jointly by U. S. military and civilian agencies. Planes will return to U. S. after the November flights.

example...

FIBERITE

Compression molded high temperature insulation materials at work...

red eye missile

for Nose Cones, Blast Tubes, Exit Cones and Aft Closures

Minimum erosion, ablation combined with dimensional stability and shock resistance over 5000°F.

Fiberite compression molded high temperature insulation materials designed for MIL-M-19536 applications; chopped fiber impregnated phenolic with special reinforcement materials as fiberglass, graphite cloth, ceramic, and quartz. Fiberite insulation is specified in the LAR, Bull-Pup, Polaris, Minuteman, Nike Zeus and many others.

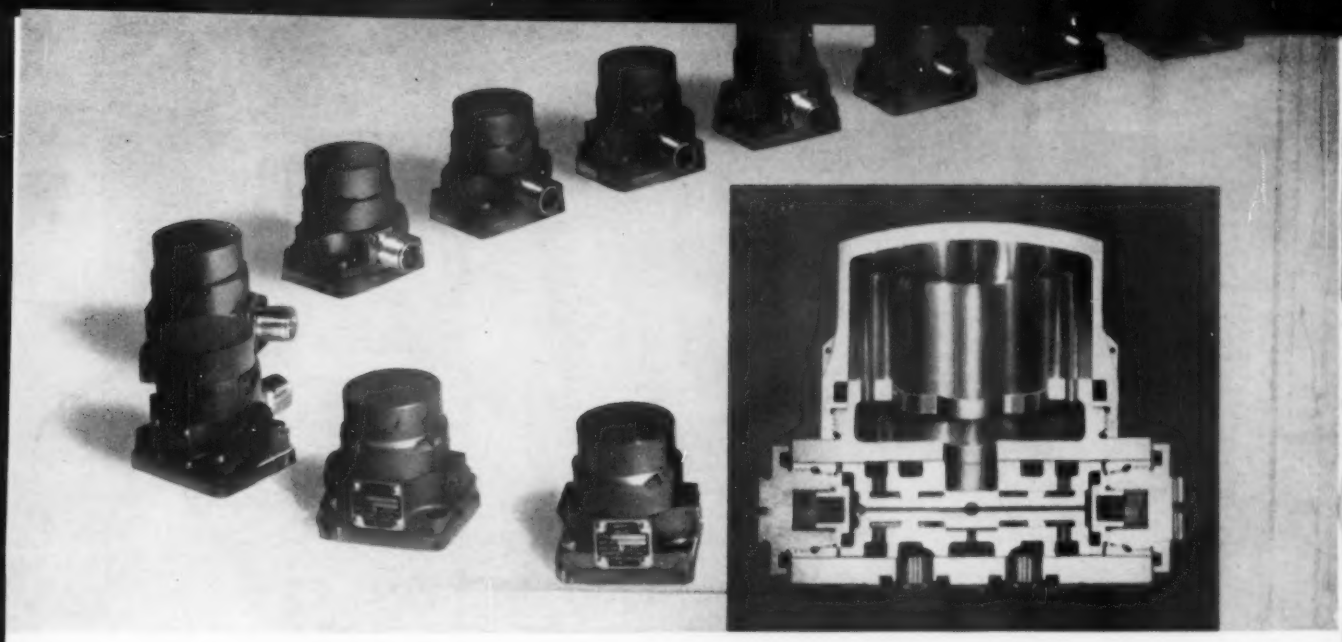
EXPLORE FIBERITE

Missile engineers will find our research helpful in solving problems requiring materials for special performance. Write factory for bulletin on high temperature insulation materials.

SALES OFFICES IN PRINCIPAL CITIES

FIBERITE MOLDING COMPOUNDS

THE FIBERITE CORPORATION
Dept. AW 10
510-520 W. 4th St.
Winona, Minnesota



How Titanium *opens the door to*

High-Volume Markets for Precision Parts...

THE KEY: ease of machining coupled with light weight and performance!

More and more component parts manufacturers are discovering that titanium clears the way to new profit sources. By substituting titanium for heavier materials, their components are performing better . . . are lighter in weight, more compact and stronger, better able to withstand corrosion, to resist deflection and dimensional loss at high temperatures.

And best of all they are finding that they are able to machine titanium parts in volume . . . to great precision . . . with the same equipment and with short lead times. In other words, *production at a profit!*

EASE OF MACHINING . . . THE KEY: Fabricators who have worked with titanium have found that it will machine in general as well as the stainless steels, with little modification in equipment.

Titanium doesn't work harden as fast as the austenitic stainless steels, copper and alpha brasses. It has a low coefficient of friction, requires low shearing forces and is free from notch sensitivity. As a result low microinch RMS finishes can be obtained. The necessary techniques — low cutting speeds, high feed rates, copious coolant, sharp tools, rigid equipment, high speed tools — are described in detail in TMCA's technical brochure "Titanium Machining Techniques." Write for your copy.

For technical information on titanium or for referral to competent fabricators of titanium components, call on the Technical Service Department of Titanium Metals Corporation of America, or the TMCA sales office in the city nearest you.

TIMET®

TITANIUM METALS CORPORATION OF AMERICA
233 Broadway, New York 7, N. Y.

SALES OFFICES: NEW YORK
CLEVELAND • CHICAGO • DALLAS • LOS ANGELES

KEARFOTT: ". . . better machining . . . faster running time . . ."

The all-titanium 6103 electrohydraulic servo valve made by Kearfott Division, General Precision, Inc., is designed for an Army ground-to-ground missile. According to Kearfott, the decision to go to titanium (Ti-6A1-4V) was based on an analysis program that generated the following comparisons:

- **Weight reduction** "Use of titanium in place of stainless steel in all structural members of the valve results in a weight reduction of 28% (4.8 oz)."
- **High strength-to-weight ratio** "Use of titanium in place of aluminum and stainless steel results in a smaller valve, without sacrificing the rugged construction essential to high-pressure hydraulic components."
- **Low thermal coefficient of expansion** "Use of titanium eliminates the danger of loosening shrink fits at elevated temperatures that would occur if stainless steel or aluminum parts were employed."
- **Corrosion resistance** "Use of titanium provides corrosion resistance equal to or better than stainless steel."
- **Machinability** "Because titanium is highly machinable, volume production is easily maintained. For most machining operations, titanium shows better performance than type 321 stainless steel. By utilizing high-powered machine tools at the proper speeds, faster running time was achieved."

VOI-SHAN: ". . . hundreds of thousands of titanium fasteners per month."

The mailed fist of the SAC is virtually held together by titanium fasteners . . . at tremendous savings in airframe weight. An estimated 100,000 titanium fasteners have replaced steel in the B-52G and in the "Hound Dog"-carrying B-52H. The weight-saving is approximately 800 pounds per airframe.

Titanium grade Ti-6Al-4V, used in most of the B-52 titanium fasteners is 43% lighter than steel and is heat-treatable to a tensile strength of 160,000 psi. In addition, it has superior fatigue resistance and atmospheric corrosion resistance.

". . . easily maintaining tolerances . . . of 0.0005"

Voi-Shan Manufacturing Company, Culver City, California, fabricates from titanium three major proprietary fastener types used in the B-52 . . . Hi-Shear rivets, Lockbolts, Hi-Torque bolts, as well as standard hex heads.

Here is what Voi-Shan reports. According to Mr. Tom Harker, Chf. Mfg. Engineer, "Titanium's ease of machining and other fabrication characteristics have enabled us to produce hundreds of thousands of titanium fasteners per month. Quality is high, too. For example, we are easily maintaining tolerances on bolt bodies of 0.0005-in. It's all a matter of proper technique."

RAYTHEON: ". . . helped us overcome . . . turbine wheel distortion . . ."

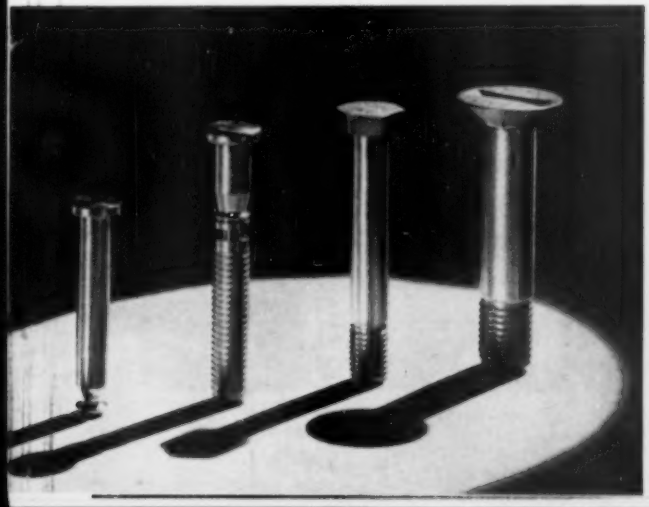
Raytheon Company, prime contractor for the Army's HAWK Missile System, switched from steel to titanium grade Ti-5Al-2.5Sn in the manufacture of its turbine wheel which actuates the missile's electrical power unit. Operated at 24,000 rpm in temperatures up to 1300°F, turbine wheel performance was previously hampered by deflection problems.

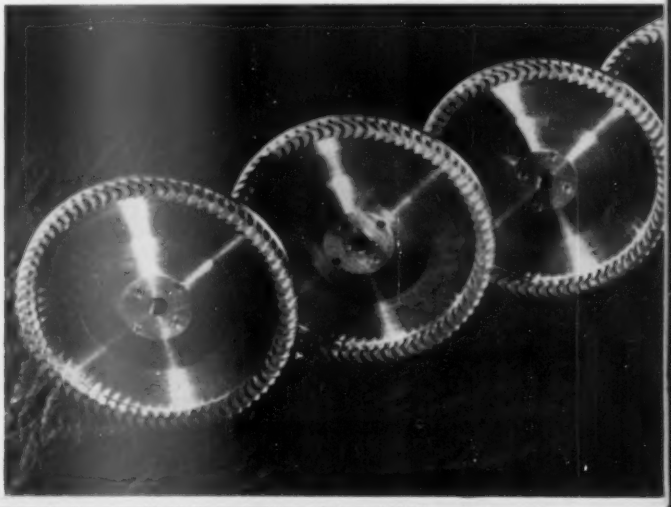
Neil Curran, Project Engineer, says, "Titanium's combination of light weight, high tensile strength and dimensional stability at high temperatures, gives us the solution to wheel distortion caused by build-up of high centrifugal forces during operation."

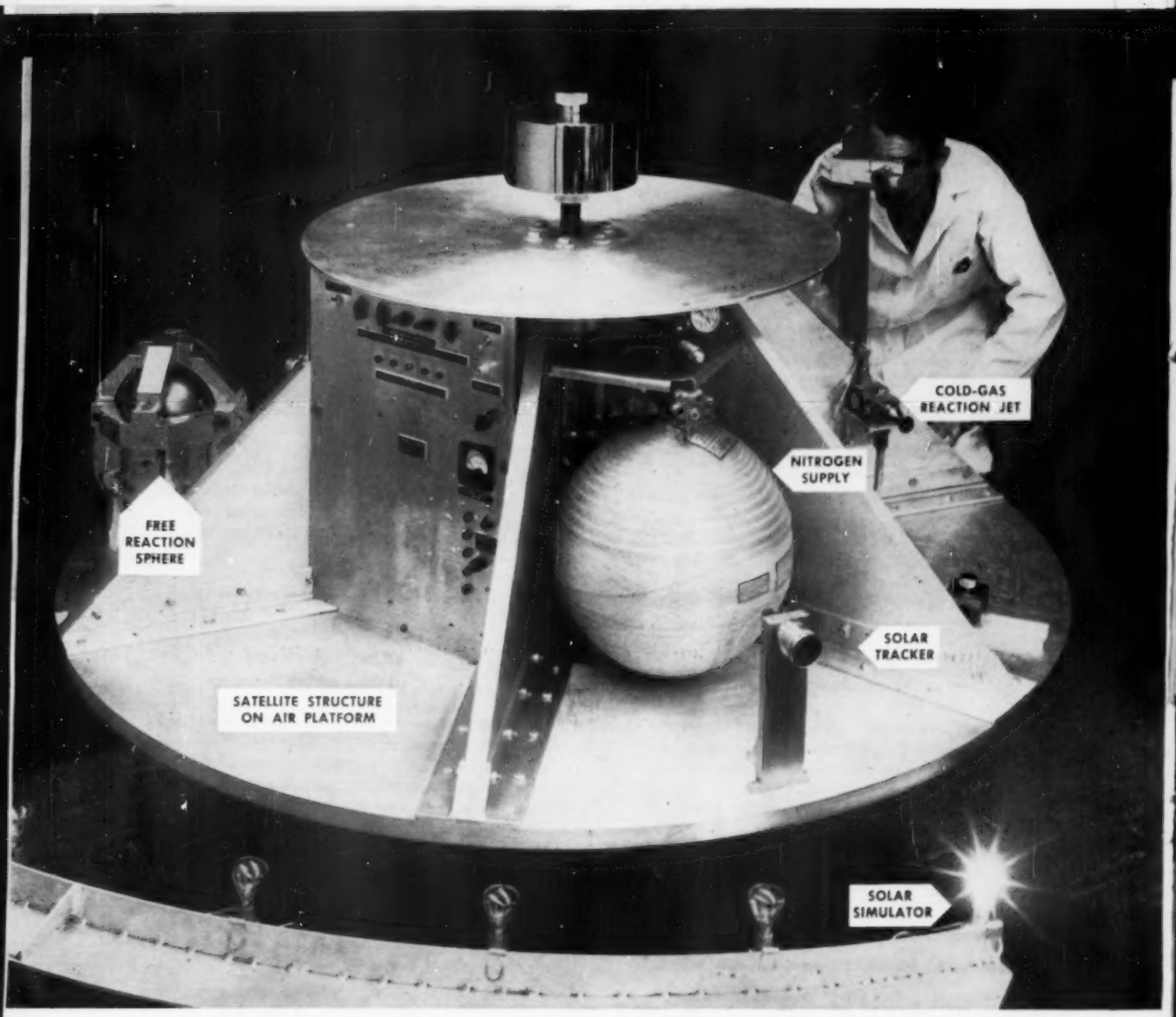
SCHELLENS-TRUE: ". . . able to reduce our machining price appreciably . . ."

Schellens-True Corporation, Ivoryton, Connecticut, volume producers of turbine wheels such as the Raytheon HAWK missile unit shown, reports a preference for titanium from a manufacturing standpoint.

Vice President E. P. Schellens says, "Since Raytheon changed from stainless steel to titanium for its turbine wheel we have been able to reduce our machining price appreciably while maintaining tolerances to 0.0002-in. and meeting delivery schedules."



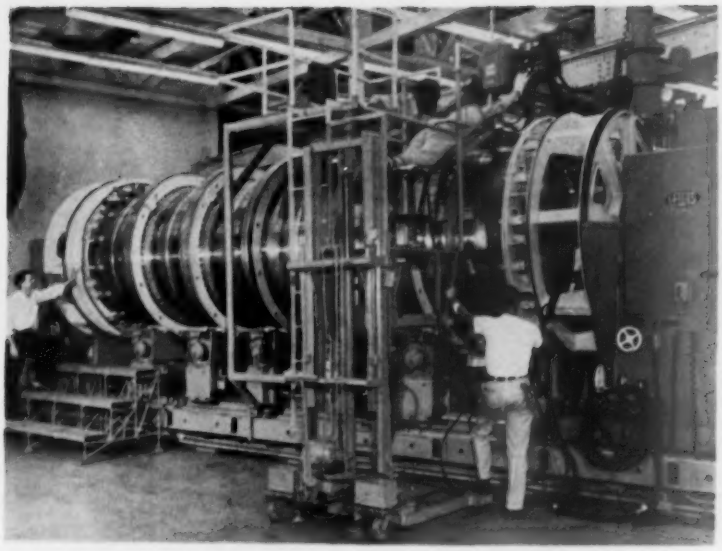




STABILIZATION IN SPACE At Bendix, we are pointing to space—with the free reaction sphere. Now under test, this advanced concept employs a single free sphere for accurate attitude control to meet tomorrow's requirements for scientific and military observatories. Career opportunities also include advanced systems development in satellite communications, infrared reconnaissance, magnetohydrodynamics, and manned space stations.

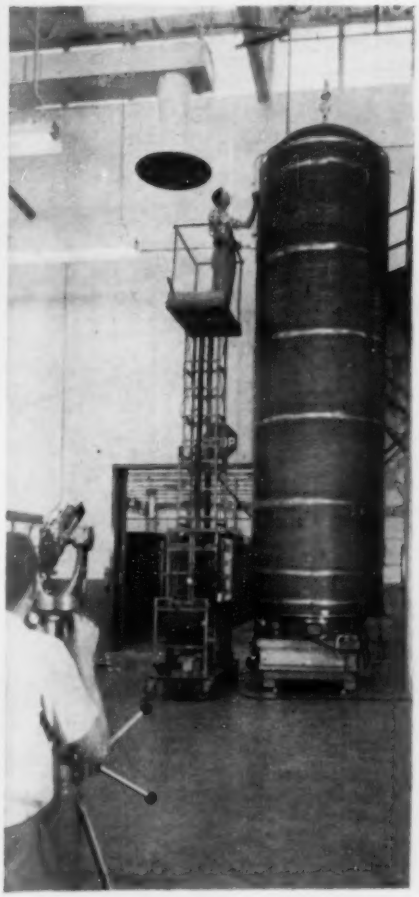
BENDIX SYSTEMS DIVISION
ANN ARBOR, MICHIGAN

THE Bendix CORPORATION

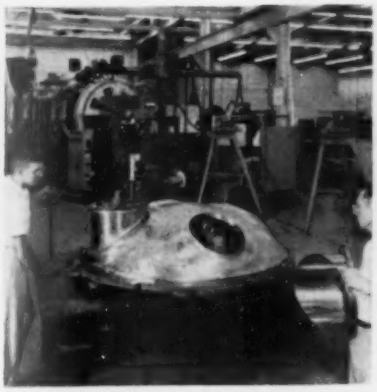


Allison Builds Minuteman Cases

First stage rocket engine cases for USAF's Minuteman intercontinental ballistic missile are being manufactured by Allison Division of General Motors under subcontract to Thiokol. Case consists of several cylindrical sections machined from high strength steel and welded in special fixtures (above). Below, inspector checks thickness of forward closure of second stage rocket case. Allison also makes Minuteman's vectoring nozzles, connected to the aft closure. Nozzles are electronically controlled.



Optical instruments are used to perform dimensional inspections on finished cases. First stage rocket engine case shown here is 20 ft. long, 65 in. in diameter.

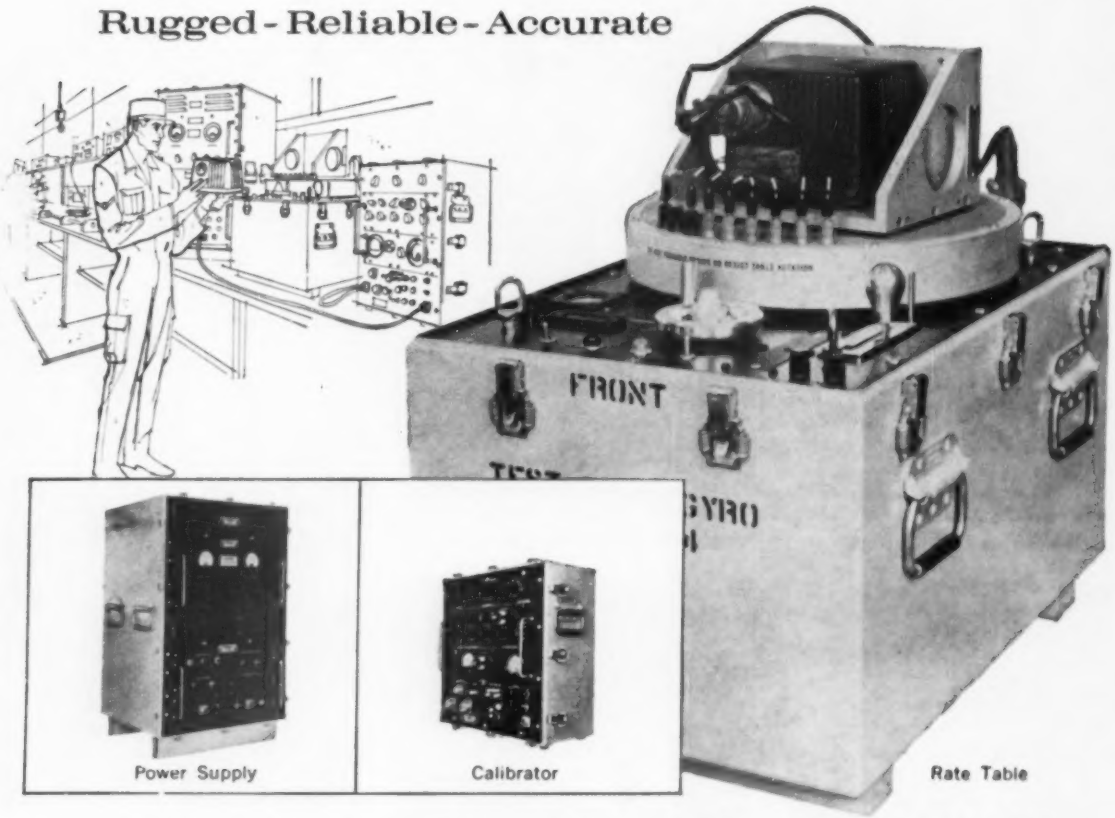


Finished and machined closure dome and nozzle adapters are assembled for welding. In background is first stage rocket engine case in welding fixture.

Use the Gyro Tester approved for USAF Air Defense Squadrons-

HONEYWELL RATE GYRO TEST SET

Rugged - Reliable - Accurate



Now you can eliminate rejection of inertial components and sub-systems by USAF Service Squadrons because of differences in test results. If you perform your quality control tests on the same type of gyro tester as that used by USAF, such discrepancies can be avoided.

The Honeywell Rate Gyro Test Set No. 32589 (FSN 4920-705-7536) has been accepted by the Air Force. Over eighty have been purchased for use at squadron level. This equipment combines the *ruggedness* to withstand the abuse of field service, the *reliability* associated with the environmental specifications of MIL-E-4970, and the *accuracy* of a laboratory instrument. Highly trained technical personnel are not required to operate this equipment.

This Gyro Test Set consists of a Rate Table, Calibrator, and precision Power Supply. *Rate Table,** with holding fixture for instrument under test, is turned at a variable angular rate up to 120 degrees per second. The Table is self-calibrating at 5 deg/sec. increments by means of a built-in stroboscope. Input rates are continuously variable. *Calibrator* permits checking pick-off voltage outputs for many other devices such as accelerometers and rate-of-turn indicators. AC pick-off output voltages can also be measured. *Power Supply* is 400 cps but other frequencies for pick-off or motor may be used. Write for Technical Bulletin BM-SGT-1 to Minneapolis-Honeywell, Boston Division, 40 Life Street, Dept. 11, Boston 35, Massachusetts.

*Available separately

CUSTOM DESIGN

For ranges up to 1200 deg/sec., and accuracies and tolerances other than described above, Honeywell can custom design and manufacture specialized Gyro Test Equipment to requirements.

75th YEAR — PIONEERING THE FUTURE

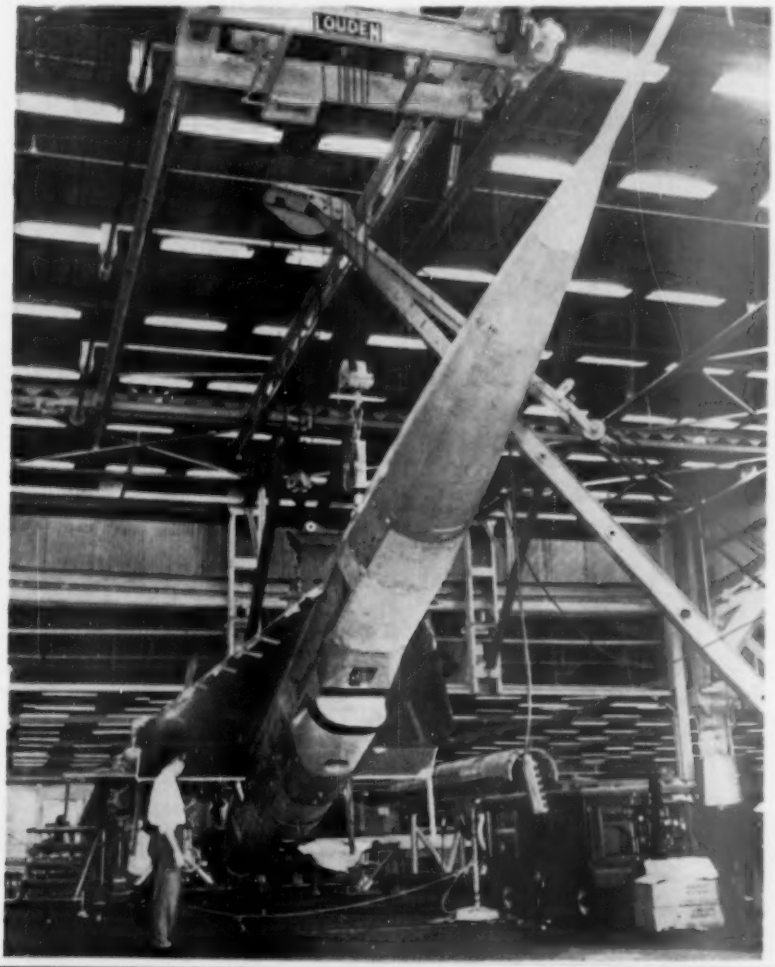
Honeywell

Military Products Group

SINCE 1885

Republic Ground-Tests SD-4 Drone

U. S. Army's SD-4 Swallow battlefield surveillance drone is undergoing extensive ground testing at Republic Aviation Corp.'s Farmingdale, L. I., facility. Above, engineers prepare for runup of the drone's Pratt & Whitney YJ60-P turbojet engine (JT12A-20). Below, the Swallow is placed on scales to determine its precise center of gravity.



Why pass up "TEFLON" know-how?

Go where it's greatest—R/M

Thousands of these R/M "Teflon" rings retain 450°F fluid under great pressure in the hydraulic systems of the X-15 . . . an example of R/M know-how — know-how that can also work for you.

Where "Teflon"* is indicated for a vital electronic or mechanical part, it doesn't pay to pass up the "Teflon" know-how of R/M.

No one knows better than R/M how to process "Teflon" into sheets, rods, tubes, tape and machined parts. No one can better meet your specs and your production schedules. From R/M you get *complete "Teflon" service*, including bondable "Teflon."

To learn what we mean by *service*, talk to the man from R/M. Call the nearest R/M district office listed below, or write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

*Du Pont TM for its TFE-fluorocarbon resin

R/M

PLASTIC PRODUCTS DIVISION

RAYBESTOS-MANHATTAN, INC.

Manheim, Pa.

BIRMINGHAM 1 • CHICAGO 31 • CLEVELAND 16 • DALLAS 26
DENVER 16 • DETROIT 2 • HOUSTON 1 • LOS ANGELES 58
MINNEAPOLIS 16 • NEW ORLEANS 17 • PASSAIC
PHILADELPHIA 3 • PITTSBURGH 22 • SOUTH SAN FRANCISCO 5
SEATTLE 4 • PETERBOROUGH, ONTARIO, CANADA

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL

HOW KAISER ALUMINUM HELPS YOU OF MILITARY PROCUREMENT

COMPLETE MARKETING ASSISTANCE. Kaiser Aluminum offers market information and assistance to companies interested in diversifying into the defense market and to companies already in defense work who are interested in other phases of the market.

Through over 50 regional, district and branch sales offices across the nation, Kaiser Aluminum maintains constant contact with the defense industry and various military and civilian agencies engaged in military procurement and manufacture. Through these offices, and with the help of our specialized Defense Industry Sales Department, we can keep you advised on defense projects being planned, currently in development, or in production.

This means we can help you evaluate specific business opportunities and industry trends in terms of your company's manufacturing and marketing goals.

BID ASSISTANCE. As another customer service, Kaiser Aluminum offers skilled assistance in bidding defense business. Through our field offices, we offer you information on current bidding and bid results on many projects.

In addition, we can help you prepare defense bids by defining and describing items to be bid, by assisting with material take offs, and by recommending aluminum alloys and production methods best suited to a profitable bid.

TECHNICAL ASSISTANCE. Our experienced aluminum designers and product engineers are available to work with your engineers on any problem concerning aluminum design and fabrication. Often, their specialized knowledge of aluminum can be effective in arriving at an efficient and economical design solution.

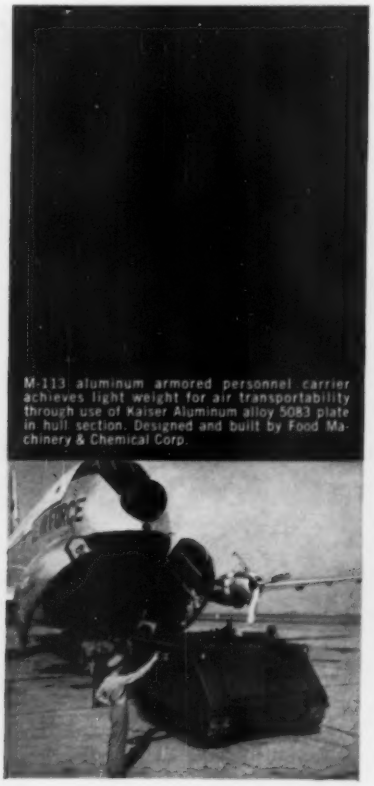
We also have available specialists in welding, machining, forging, casting, forming and other fabricating methods. When metal forming, joining or finishing problems arise, these technicians are available at no cost to you for consultation with your production and technical people.

METALLURGICAL ASSISTANCE. Kaiser Aluminum operates a complete metallurgical research establishment at Spokane, Washington, and maintains specialized research facilities in California, Louisiana, Illinois and Rhode Island.

Our Department of Metallurgical Research conducts continuous research and testing resulting in new alloys, improved joining techniques and applications of particular value to the defense industry. For example, this Department has been instrumental in the development of alloys suitable for armor plate, and has conducted extensive armor research at its ballistic firing range at Spokane.

The Department of Metallurgical Research can help you solve a wide range of aluminum application and metallurgical problems.

U.S.S. Dewey, one of the Navy's newest missile-firing frigates, has a lightweight all aluminum superstructure constructed of welded, high magnesium aluminum alloys. Weight is cut two-thirds —over a 1,200,000 pound reduction. Built by Bath Iron Works, Bath, Maine.



M-113 aluminum armored personnel carrier achieves light weight for air transportability through use of Kaiser Aluminum alloy 5083 plate in hull section. Designed and built by Food Machinery & Chemical Corp.

Use of aluminum in M-60 tank contributes to greater cruising range and increased mobility. M-60 weights 51 tons — 3,000 lbs. less than M-48 model. Road wheel hubs are Kaiser Aluminum forgings. Other aluminum parts: fuel tanks, fenders, turret platform floor and road wheel discs. Designed and built by Chrysler Corporation under direction of U. S. Army Ordnance Tank-Automotive Command, Detroit, Michigan.

MEET THE SPECIAL REQUIREMENTS AND MANUFACTURE

NATIONWIDE PRODUCTION FACILITIES. Kaiser Aluminum's production facilities include 25 plants throughout the nation and abroad. These plants offer a completely integrated operation from the mining of bauxite to the final production of finished mill products such as sheet, plate, forgings, extrusions, rod, bar and wire, pig and ingot, foil, electrical conductor and chemicals.

At Ravenswood West Virginia, we operate the most modern integrated sheet and plate mill in the world. Here is the industry's largest plate stretcher—with a 30-million pound pull capacity. This giant stretcher makes possible the rolling and straightening of the heaviest wide plate manufactured.

Other manufacturing facilities include sheet and plate mills at Trentwood, Washington; forging facilities at Erie, Pa.; matched 8,000-ton extrusion presses at Halethorpe, Maryland; and a complete rod, bar and wire mill at Newark, Ohio.

The new T-196-E1, self-propelled 155-mm. howitzer, has aluminum armor plate, wheels and other components. The T-196-E1 weighs approximately 46,000 lbs. as opposed to 64,000 lbs. for the M-44 which it replaces. Designed by Ordnance Tank-Automotive Command. Vehicle engineering agency is Cadillac Cleveland Ordnance Plant, GMC.

WE'RE IN BUSINESS TO SERVE YOU. All of the services and facilities mentioned here are at your disposal right now. Why not take advantage of our broad range of sales and technical experience today? Your phone call or letter will receive our immediate attention. Contact your local Kaiser Aluminum sales office listed in the classified pages of your phone book, or write: *Kaiser Aluminum & Chemical Sales, Inc., Kaiser Center, 300 Lakeside Drive, Oakland 12, California.*

Specially designed reusable Polaris missile container employs use of welded Kaiser Aluminum alloys 6061 and 5083. Container has shock absorber system and special environmental controls for proper missile transit, handling and storage. Designed and built by Lockheed, Sunnyvale, Calif.

FREE PORTFOLIO! *"Aluminum in the Defense Industry"* is a file folder full of information on the many uses of aluminum for military applications. It includes facts about the characteristics and properties of aluminum, important findings regarding welding alloys 5083 and 5086 as used in missiles, ground support equipment, cryogenics and other military applications, plus booklets covering Kaiser Aluminum mill products availabilities and designing with aluminum. For your free portfolio—mail the coupon now!

KAISER ALUMINUM & CHEMICAL SALES, INC.
DEPT. DE-189, KAISER CENTER
300 LAKESIDE DRIVE
OAKLAND 12, CALIFORNIA

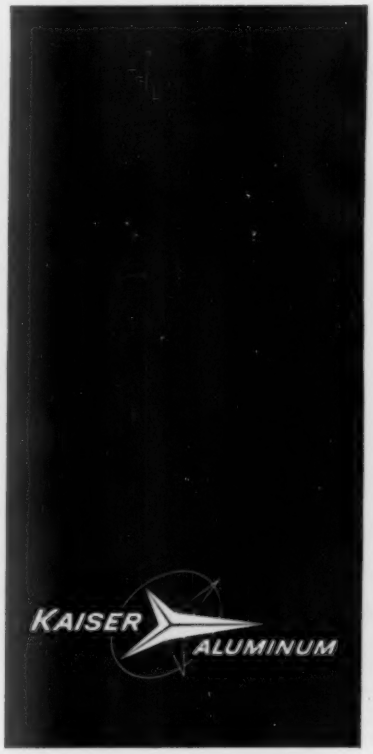
Please send me your free portfolio, *"Aluminum in the Defense Industry."*

NAME_____

ADDRESS_____

CITY_____

STATE_____



Cockpit Monitor Sets Best Climbout

By Barry Tully

White Plains, N. Y.—Optimum climbout and approach paths for jet transports under varying weight, drag and power conditions may be possible with a speed control instrument integrating lift and acceleration measurements.

The flight director system, called SCAT (speed control-approach/takeoff), was developed by Safe Flight Instrument Corp. to provide precise attitude/power requirements to pilots on climbout and during landing approach. In addition to the SCAT system's use in standardizing flight paths, the instrument is being offered as an aid in noise abatement, in that maximum safe climb rates and steeper descent paths may be more readily followed.

Signal Combination

SCAT is an extension of Safe Flight's speed control system which was developed from the company's stick shaker and other stall warning devices. The SCAT system combines the lift measurement from the wing-mounted transducer with an acceleration signal to provide an integrated lift/speed indication presented in a manner easily flown by the pilot.

Safe Flight demonstrated its SCAT system to AVIATION WEEK in the company Beechcraft Twin Bonanza in which demonstrations are made to airlines and aircraft manufacturers. C. F. Baldwin, chief of flight operations accompanied this AVIATION WEEK pilot.

At Westchester County Airport, marginal VFR conditions (1,100 ft. and 3 mi.), plus instrument traffic and a bounce pattern combined to prevent us from paying detailed attention to the SCAT system. Nonetheless, Baldwin managed to demonstrate the SCAT system.

Initial Takeoff

Initial takeoff was normal with liftoff at about 80 mph. Baldwin raised the gear, directed my attention to the SCAT indicator, and instructed me to ignore indicated airspeed. The indicator needle, which moves through an arc from center (right-fast, left-slow), is identical with the Safe Flight speed control instrument. The system is preset to indicate any desired climb speed when the needle is vertical.

As might be expected on climbout with a strange aircraft on a long runway, my first look at SCAT showed the needle pegged on fast. Maintaining full power, I brought the nose up until the needle returned to the vertical or on-speed position. Continued back pressure brought an immediate slow indication on the instrument necessitating nose-down elevator correction.

The SCAT indicator, with the aircraft maintaining near-constant power on climbout, responds chiefly to elevator control movements. Reduction of power, however, causes a slow indication requiring a corresponding reduction in angle of attack. The indicator presents best climb attitude as long as power to climb is available, and responds to changes in drag caused by lowering the landing gear.

To demonstrate what the ground plane accelerometer does for the SCAT system, Safe Flight has installed a switch which removes the accelerometer from the system. The SCAT indicator then becomes simply a speed control lift system operating from the wing-mounted lift transducer. The indicator will still bring the aircraft to its best climb attitude; however, the absence of the accelerometer signals puts a lag in the instrument. Thus the pilot, seeking to hold the aircraft in the best climb attitude by means of the instrument, will fly the aircraft through a series of diminishing phugoid-like oscillations before the plane steadies on its proper attitude for best climb.

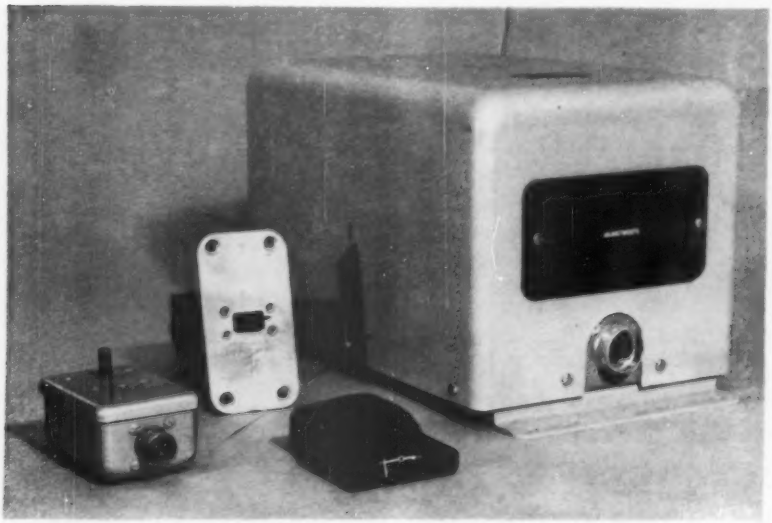
The forgiving performance of an aircraft like the Beechcraft Twin Bonanza, with its ample power loading and broad margin of climb attitude, serves to handicap the aircraft as a vehicle to demonstrate the precision takeoff and climbouts, particularly when operating from long runways at considerably below maximum gross weight.

While the instrument still indicates the best climb attitude, the airspeed and vertical speed indicator will suffice in most instances.

Reduced Power

Baldwin, to overcome this deficiency, suggested a reduced power takeoff to demonstrate the SCAT system's reaction to an over-rotation on takeoff. At Baldwin's suggestion I added only 15 in. of manifold pressure on the engines instead of a normal 27 in. Overriding my better judgment, I pulled the nose high at a rolling speed of 60 mph. The plane stayed on the runway in a tailscraping attitude and the SCAT needle pegged on slow. Baldwin then added about 5 in. of manifold pressure to the engines and instructed me to fly the SCAT indicator. I lowered the nose to center the SCAT needle, the plane accelerated, we skipped once and were airborne, climbing at what the SCAT system indicated was the best rate of climb for the reduced power setting.

While the SCAT indicator responds chiefly to elevator position on climbout, on landing approach it is controlled



SCAT system components include a ground plane accelerometer, wing mounted lift transducer, signal summing unit and the panel-mounted SCAT indicator.

chiefly by means of adjusting power. The system, set for landing automatically upon setting approach flaps, provides precise indication of present landing speeds based on the combined lift and acceleration measurement. Again, the lack of lag in the system permits making corrections merely by centering the SCAT pointer either by means of nose position or power adjustment. The SCAT system was flown to a point over the end of the runway where a normal visual landing was made.

The SCAT system is not a runway monitor, i.e., it does not monitor takeoff acceleration, comparing it with that desired for particular conditions of weight, and other parameters. Safe Flight emphasizes that the system offers useful information to the pilot upon takeoff rotation, climbout and on leanding approach.

System Details

Safe Flight's standard speed control system measures the ratio of the coefficient of lift over coefficient of lift maximum ($C_L/C_{L_{max}}$) by means of a wing-mounted pressure sensor. The signal proportional to this ratio is sent to a speed control indicator or to a stick shaker or other stall warning device.

The system was expanded to form the SCAT system by adding a gyro-oriented ground plant accelerometer. An adapter was added to the original signal summing unit and the signals from the lift transducer and the accelerometer are added electrically. The signals are combined so that decreasing lift ratio and forward acceleration add in a direction to cause a "fast" indication of the SCAT pointer. Increasing lift ratio and deceleration signals combine to cause a "slow" deflection of the needle. The lift ratio signal and the acceleration signal add or subtract to produce a net signal indicative of the combined lift and forward acceleration at a given moment. The speed control system consists of the wing lift transducer, signal summing unit, flap position transmitter, speed control indicators, and stall warning signal (if required). The additions to the system to provide full SCAT capabilities are the gyro-oriented linear accelerometer, the SCAT adapter unit and a test switch.

The SCAT system has no operational controls other than a circuit breaker and a "test" switch. An "off" flag is incorporated to warn the pilot of an electrical malfunction.

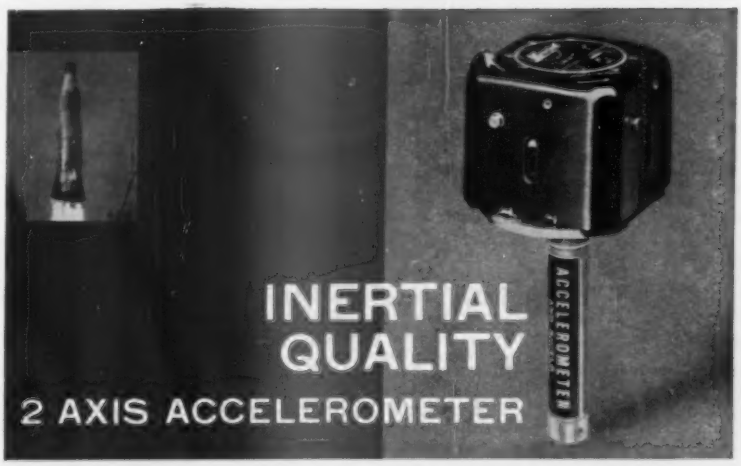
The ground plane accelerometer group contains sequencing relays which control the functions of the SCAT system. Upon activating the aircraft electrical system, power is applied to the speed control group. The indicator "off" flag will then withdraw. Power is next applied to the ground plane accelerometer group and the "off" flag

Is Noted For:

- **20 YEARS OF SERVICE** to military and commercial aircraft/missile manufacturers supplying **MS-NAS-AN** fluid line fittings and all *special fittings* including swivel, adjustable and positioning fittings.
- **ENGINEERING AND TECHNICAL ABILITY** that has eliminated inter granular corrosion and eutectic melting problems in fittings. (Data available upon request.)
- **CUSTOM ENGINEERING** and design for fittings of all materials.
- **QUALITY CONTROL** through *complete* engineering and test facilities.
- **PROMPT DELIVERY** from Dania, Florida or Whittier, California.

WRITE OR WIRE. DEPT. A-10
The AIRCRAFT FITTING COMPANY • 701 N. Fed. Hwy., DANIA, FLORIDA

DISTRIBUTORS INQUIRIES INVITED



Highly precise and accurate, Kearfott two-axis accelerometers are pendulous devices which sense airframe acceleration forces acting on them.
An inverted pendulum utilizing a unique Hooke's joint suspension displaces as a function of acceleration in either of 2 axes. An AC pickoff signal is rectified and applied to voice coils restoring the pendulum to null. The DC required for restoration is proportional to acceleration. Typical characteristics for these units include range of ± 25 g's, scale factor of 5.0 ma/g, linearity of ± 0.005% and threshold of 2×10^{-7} g's.

KEARFOTT DIVISION
Little Falls, New Jersey
GENERAL PRECISION, INC.
Other Divisions: GPL, Librascope, Link

your map in a **UNIVERSE** of AIRCRAFT PUMPS

This new engineering bulletin leads you right to the hydraulic pump designs you may be looking for. Here, passing on parade, are high performance gear pumps made to the measure of the next generation in aircraft, missiles, spacecraft, and support equipment.

Many of these units are the product of ready-made, mass-produced components that can be teamed into the precise configuration you need. Custom-designed pumps are also available.

All have in common these classic Eastern hydraulic pump characteristics:

SMALL SIZE: Eastern gear pumps are the smallest, lightest made. Airborne servo system pump shown delivers 1.5 gpm @ 1500 psig — measures only 1⅞" x 1⅞" x 2¾", weighs 9 oz.

WIDE PERFORMANCE RANGE: pumps available have theoretical displacement from .0016 to 1.30 cu. in. per revolution — flow from .025 to 9.6 gpm, pressures from 0 to 2000 psig, at speeds to 24,000 rpm. Weights with motor range from 1.5 to 8.5 lbs.

UNAFFECTED BY EXTREME ENVIRONMENTS: rugged, reliable Eastern units take loads to 50g in stride — shrug off temperature differentials to meet MIL specs.

EASTERN AVIATION PRODUCTS

EASTERN INDUSTRIES INCORPORATED

100 SKIFF STREET • HAMDEN 14, CONNECTICUT
WEST COAST OFFICE • 4203 SPENCER ST. • TORRANCE, CALIF.

Other Eastern products:
- **hydraulic motors**
- **servovalves, amplifiers, actuators and systems**
- **pressurization/dehydration packs**
- **quick-disconnect couplings**
- **electronic tube cooling units**

will reappear until the gyro is up to speed. Safe Flight emphasizes, however, that 5 min. should elapse between energizing the electrical system and use of the SCAT system.

Operation of the "test" switch causes the "off" flag to appear; however, if all is well it will withdraw after a few seconds. Any reappearance of the "off" flag indicates system malfunction. This final check is made with the aircraft on the runway in position for takeoff.

The initial acceleration of the takeoff roll actuates a relay which removes the erection signals to the gyro. During the takeoff period (90 sec. max.) the accelerometer provides only acceleration or deceleration signals which are added to the lift ratio signal. After takeoff the erection signals are restored to the gyro and the signal from the accelerometer then consists of the integrated change of acceleration, rather than acceleration. The time constant of integration is such that 63% of the signal is erased in 10 sec.

Thus, errors in gyro erection do not affect system accuracy, Safe Flight says.

During cruising flight, the SCAT indicator will show the lift condition of the aircraft in stable flight. The system is disregarded during this flight condition.

Landing Approach

During the approach to a landing the SCAT system responds to changes in flap position and deflects to represent the desired lift conditions during approach. The pilot then monitors his SCAT indicator, adjusting power and elevator control as required to maintain optimum approach path. On landing, the SCAT system is automatically resequenced and is ready for the next takeoff.

In the event of a late go-around the system responds to the application of power acceleration and flap angle change and indicates the proper attitude for climbout at any given power and climb flap setting.

According to Safe Flight, speed control by means of its lift transducer is more accurate than an airspeed reading at climbout and approach airspeeds and high angles of attack.

Boeing will install Safe Flight's speed control (without the ground plane accelerometer) as standard equipment on its 720 model and on all 707s with the vertical fin modification. Safe Flight plans to offer the complete SCAT system to airlines.

It appears that the SCAT system would be particularly advantageous in strict noise abatement areas where maximum safe climb rates must be accomplished until designated altitudes are reached. Following this noise abatement departure, pilots could fly cruise climb airspeeds.

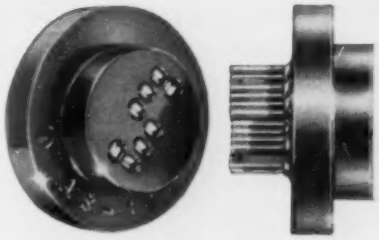
LET'S PLUG

FOR BETTER TESTING WITH EECo'S TEST SOCKETS

Now all header-terminal components automatically become plug-in devices for test and evaluation, when you test solder-terminal relays, transformers, crystal cans, etc., with the new EECo universal test socket series.

Dual, isolated contacts for each terminal on header eliminates solder joints or clip leads.

Many standard configurations available, immediate delivery. New techniques make special sockets available at standard socket prices.



AS-Series Test Sockets

EECo RT-905 RELAY TESTER for faster, more accurate testing. Measures voltage and current simultaneously, both pull-in and drop-out time, contact bounce. Automatic relay driving circuitry. Oscilloscope connections and circuitry.

SEND FOR DATA SHEETS AS-101 AND RT-905.

Anaheim Electronics Division

Electronic Engineering Company *of California*

1601 East Chestnut Avenue • Santa Ana, Calif. • Kimberly 7-5501 • TWX: S Ana 5263

EE O-13

FLOATED RATE INTEGRATING GYROS

Specifically designed for missile applications, these Kearfott miniature gyros are available with short term drift rates of 0.01°/hr. Their outstanding accuracy and performance make them superior to any comparably-sized units on the market. Wide angle displacement gyros with high torquing rates for "strap-down" applications are also being produced. Performance characteristics that are even more precise can be provided within the same dimensions.

KEARFOTT DIVISION
Little Falls, New Jersey

GENERAL PRECISION, INC.
Other Divisions: GPL Librascope, Link

Space Electronics Corporation is actively engaged in both creating and constructing a wide variety of advanced electronic systems vital to continued progress of the nation's missile and space programs. Significant demonstrations of this ability are two highly miniaturized systems conceived and fabricated by SEC for CalTech/NASA Jet Propulsion Laboratory. Consuming less than 1 watt each, they are the Digital Data Automation System and Spacecraft Radio Command System for the advanced lunar and deep space probe known as . . .

Ranger

SPACE ELECTRONICS CORPORATION

930 Air Way Glendale 1, California CHapman 5-7651

Inquiries from qualified scientists and engineers are invited to the personal attention of Dr. James Fletcher, president.

New Heat Exchanger Cools B-58 Avionics

Environmental control system on a specially modified Convair B-58 is augmented by a Freon vapor-cycle system incorporating a water-to-fuel heat exchanger. Hamilton-Standard Division of United Aircraft Corp., designer of the system says that it is the first use of fuel heat exchanger on an operating aircraft.

The B-58, used in the development of Hughes Falcon air-to-air missiles, fires, guides and tracks the missiles at high speeds. The added avionic cooling load requires an additional 12 tons of refrigerating capacity over the aircraft's normal 16-ton open cycle system (AW Dec. 15, 1958, p. 106).

Fuel is pumped from the B-58's fuel cells to a heat exchanger where it lowers temperature of a water glycol solution. This water glycol mixture is then piped to a Freon vapor-cycle refrigeration unit for ultimate cooling. The primary advantage of the fuel heat sink is that it minimizes the weight penalty. Hamilton-Standard says the system operates automatically over a temperature range of from below zero to over 200F.

Heated Windshield Cuts X-15 Fogging

Windshield fogging problems uncovered in the first North American X-15 glide flights have been solved with the installation of specially designed, electrically-heated laminated glass manufactured by the Sierracin Corp. Original defogging system for the rocket research craft utilized a nitrogen purge system comprised of two panes of glass with a space between. The outer pane was a non-structural heat shield and the inner pane was laminated semi-tempered glass.

The new Sierracote windshield, now installed on all three X-15s, obtains defogging action as a result of electric current which is passed through a transparent, conductive coating on the inner surface of the laminated glass. To ensure uniform heating of the irregularly shaped windshield, the Sierracote was applied with a gradient resistivity—higher at the narrow end than at the aft or wider end. A special, high-vacuum technique was used in applying the coating.

Necessary resistance to aerodynamic heating is afforded by a high temperature innerlayer material, Silastic K, developed by Dow Corning. The resulting laminate is two plys of 0.125 semi-tempered glass with an innerlayer of 0.040 Silastic which will withstand temperatures up to 350F.

TAILPIPE transducer is shown at right.

Cockpit Indicator Measures Thrust

Cockpit instrument, providing instantaneous indication of engine thrust in pounds, is being evaluated on jet transport aircraft.

The thrust indicator, developed by the Industrial Acoustics Corp., New York, N. Y., is based on a phenomenon that jet engine noise level is directly proportional to thrust. Industrial Acoustics' TI-1 thrust indicator measures the sonic energy in the mid-frequency range with a transducer mounted in the nacelle near the jet tailpipe. The cockpit indicator is calibrated to record the sonic intensity in pounds of thrust.

The directional qualities of the sound transducers are intended to eliminate interference from other engines in muti-engine aircraft. The TI-1 has undergone testing on ground installation and proved successful. The in-flight test program, being conducted on a TWA Convair 880, is to determine whether or not the accuracy of the instrument is diminished by in-flight noises.

The instrument, tested in the 4,000 to 15,000 lb. thrust level, is accurate to plus or minus 0.5%, according to Industrial Acoustics. The instrument operates on 28 v.d.c. and will be available in 100 v.a.c. The weight of the instrument is 2.0 lb. and the transducer weighs 0.9 lb.

PRODUCTION BRIEFING

General Electric Ordnance Dept., Pittsfield, Mass., will develop and fabricate prototypes of the Mk. 44 Mod 1 ASROC homing torpedo under $1 million Navy contract. In addition to its use in the ASROC system, the Mk. 44 acoustic homing torpedo may be dropped from aircraft and launched from the decks of surface vessels. GE's

PROBLEMATICAL RECREATIONS 36

A ball is dropped from a height of 10 feet. It rebounds one-half the distance on each bounce. What is the total distance it travels?

—Mathematics Magazine

LAND is *L*itton's *A*ngular *N*avigation *D*evelopment, a project of our Maryland Division, inspired by the Army's need for highly precise surveillance equipment that can operate without degradation over any terrain at ranges of several hundred miles.

ANSWER TO LAST WEEK'S PROBLEM: The permutations of 12 things divided by the 60 symmetries of the dodecahedron, or 7,983,360.

LITTON INDUSTRIES
Beverly Hills, California

MAXIMUM ERROR 20 SECONDS ARC

Available in both conventional and gimbal mounted configurations, these synchros provide component accuracies of 20 seconds of arc or better. They permit RMS accuracy for 3 unit strings of better than 0.75 minutes. Specifically designed for precise data transmission in missile-borne applications, these components eliminate the need for 2 speed servos and complex electronics, provide increased reliability and marked improvement in over-all system performance.

KEARFOTT DIVISION
Little Falls, New Jersey

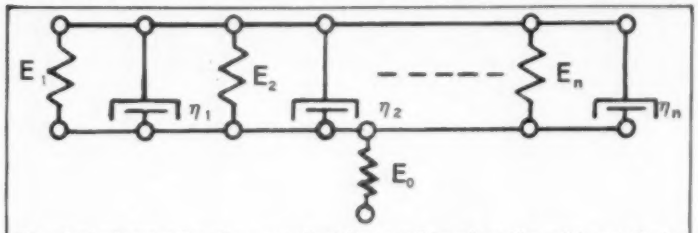
GENERAL PRECISION, INC.
Other Divisions: GPL, Librascope, Link

Grand Central Rocket
REPORT

STRUCTURAL INTEGRITY OF SOLID PROPELLANT GRAINS

The demand for ever larger rocket motors, coupled with the importance of mobility, fast countdown and low cost, steadily increases the importance of solid propellant rockets. To extend the state-of-the-art, Grand Central Rocket Co. has accelerated an important research project on the amount and materials under various combinations of time and force, such as during ignition (short time, large force); in flight (less force, longer time); or during storage (thermal cycling and gravity forces, for a long time).

From the research being conducted, engineers will be able to design large



The physical properties of a generalized linear solid such as the solid propellants under test in the GCR Research Project may be expressed as a mechanical analogue to a first order approximation. A more generalized description may be obtained by using a mathematical analogue.

$$\left[a_n \frac{\partial^n}{\partial t^n} + \cdots a_2 \frac{\partial^2}{\partial t^2} + a_1 \frac{\partial}{\partial t} + a_0\right] \sigma(t) = \left[b_m \frac{\partial^m}{\partial t^m} + \cdots b_2 \frac{\partial^2}{\partial t^2} + b_1 \frac{\partial}{\partial t} + b_0\right] \epsilon(t)$$

Transform techniques are often used to obtain solutions to this mathematical analogue.

Real propellants require non-linear techniques for complete definition. This is being done at GCR by the combined use of a mathematical analogue and experimental methods.

cause of physical deformation or propellant "slump" in very large solid propellant motors.

Because the solid propellant is essentially a rubbery, visco-elastic material, it may be deformed—similar to rubber—by time dependent forces. However, its behavior is strongly influenced by conditions of loading and is particularly "fate" sensitive. Under extreme conditions this deformation can cause failures.

The studies by Grand Central Rocket's research team will attempt to establish criteria for the amount of deformation of various solid propellant motors which have known values of structural integrity—and resultant operational reliability.

Grand Central Rocket scientists and engineers are developing design criteria based on visco-elastic theory—a basic step necessary before very large missile motors may be designed with high reliability.

The project is another demonstration of Grand Central Rocket's unique capability to handle difficult assignments in the field of rocket motor and propellant research—a capability assured by one of the nation's finest rocket research and design teams.

Positions open for visco-elasticians, elasto-kineticists, applied physicists and applied mathematicians

GCR
GRAND CENTRAL ROCKET CO.

GRAND CENTRAL ROCKET CO., Redlands, Calif. • Box 111 • PY 3-2211

Ordnance Department will produce sea water batteries for the electric Mk. 44 under $1.4 million contract.

Fairchild Engine and Airplane Corp., Hagerstown, Md., will produce aluminum pleasure boats in 15 to 19 ft. models for the 1961 boating season. The diversification move will attempt to employ stretch-forming techniques developed by Reynolds Metals.

Hamilton Standard Division of United Aircraft, Windsor Locks, Conn., will deliver fuel control test stands to the Navy to test fuel controls on Allison T56, General Electric T58 and T64 turbine engines. The test stands will be used at overhaul and repair facilities at North Island and Alameda, Calif., Jacksonville, Fla., and Norfolk, Va.

Menasco Mfg. Co., Burbank, Calif., will build pressure vessels for the Martin Titan intercontinental ballistic missile under a $500,000 contract. The company's pressure vessel backlog is reported to exceed $1.5 million.

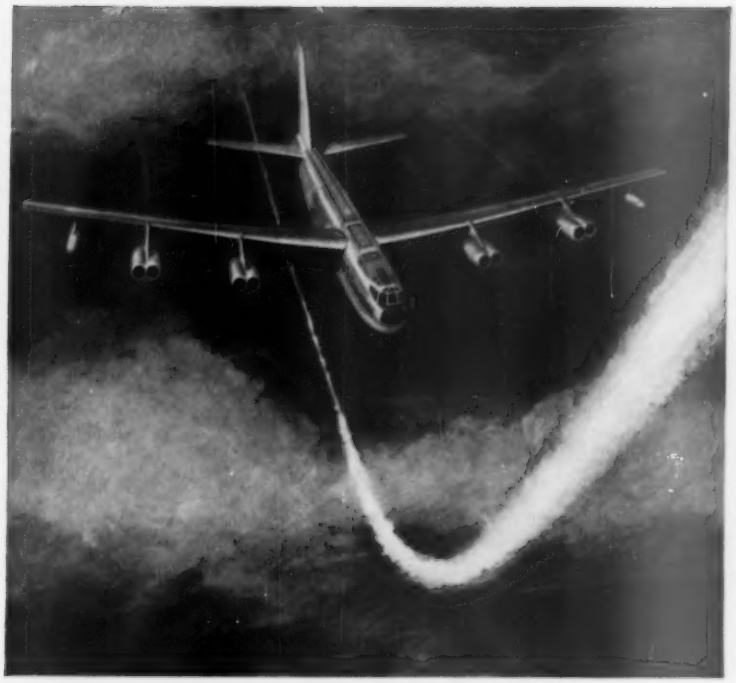
Kellogg Division of American Brake Shoe Co., Rochester, N. Y., will provide a motor-pump package for hydraulic nose-wheel steering of the Fairchild F-27. The hydraulic nose-wheel steering unit will be installed on production aircraft and will be offered to users as a replacement for the original pneumatic design.

Kearfott Division, General Precision, Inc., Little Falls, N. J., will build hydraulic control systems for the Martin Pershing Army solid fueled ballistic missile. The control systems, to be produced under $1.3 million contract, consist of electro-hydraulic servo valves, an integral electric motor pump, a pressurized sump and two synchronized rotary output shafts. The units are electrically connected to the missile's power and guidance systems.

General Electric Ordnance Department has received Navy contracts of more than $4.4 million for production of Tartar fire control directors, manufacture of Mk. 44 torpedo sea water batteries, development and prototype fabrication of Mk. 44 Mod. 1 torpedoes for ASROC anti-submarine missile system.

North American Aviation's Columbus Division is testing a rocket-powered ejection seat for VTOL aircraft that is expected to permit safe ejection from ground level to 10,000 ft.

Kaman Aircraft Corp. has been awarded a $21 million production contract to supply Navy with single rotor HU2K utility helicopters.



KEARFOTT is producing

precision floated gyros for the

Skybolt missile

Engineers: Kearfott offers challenging opportunities in advanced component and system development.

KEARFOTT DIVISION
Little Falls, New Jersey

GENERAL PRECISION, INC.
Other Divisions: GPL, Librascope, Link

NEW AVIATION PRODUCTS

Light Aircraft Starter

Direct current engine starter is intended for reciprocating aircraft engines with displacements up to 1,000 cu. in.

The starter, Model No. 20081-000, operates on 13.5 to 24 v.d.c. An

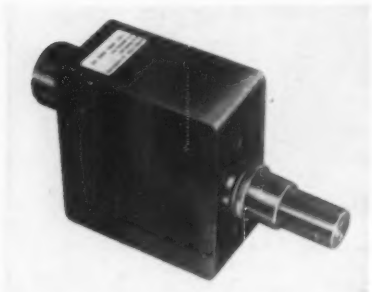
externally adjustable clutch providing protection against engine shaft damage is set to slip at 300 ft./lb. The jaw is automatically engaged with the engine jaw upon energization and is disengaged after starting.

Jack & Heintz, Inc., P. O. Box 6719, Cleveland 1, Ohio.

Liquid Level Indicator

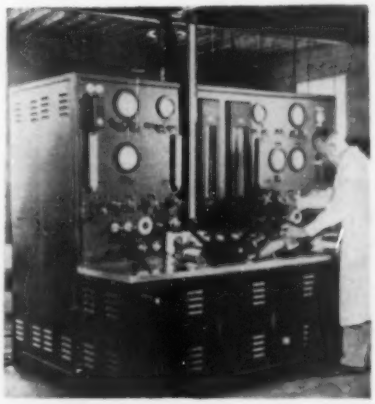
Liquid level sensor is designed to indicate low liquid levels of lubricants and other high temperature liquids on aircraft and industrial engines.

The liquid level indicator, tested on a Pratt & Whitney J75, is said to func-



tion reliably despite heat and vibration. The electronic control and sensing element are combined in a single unit; warning is given by means of a light or horn.

Electronics Dept., D-40, Hamilton Standard, Broad Brook, Conn.



Oil System Tester

Test stand is designed for airliner heat exchanger and oil radiator testing.

The test unit, in addition to air-to-oil and oil-to-fuel heat exchangers, will check the performance of fuel temperature regulators and oil and fuel system components on Douglas DC-8, Lockheed Electra, Boeing 707 and Convair 880 and 600 aircraft.

Bendix Support Equipment, South Bend, Ind.

Induction Motor

Explosion-proof induction motor is designed to drive an airborne jet fuel pump. Other applications include driving gear pumps and compressors. The fan-cooled DF-15-5, with detachable base and mounting flange, conforms to MIL-M-7969A, MIL-E-5272A and MIL-R-6106. Other specifications include: 0.15 hp., 208 v., 400 cps., three-phase, 5,300 rpm., torque (full load) 28.5 in. oz., torque (starting) 84.0 in. oz., efficiency 67.5%, weight 4.75 lb.

Kearfott Division, General Precision Inc., 1150 McBride Ave., Little Falls, N. J.

Turbine APU Tester

Ground checkout equipment is designed to complete tests of airborne turbine auxiliary power unit electronic circuits in eight minutes. The computer unit, designed for the Boeing KC-135 tanker aircraft, performs 55 successive checks.

Used in conjunction with a field handbook, the electronic tester indicates system malfunctions with red light indications. The test stand has a fuel supply and turbine silencers so that the turbine unit may be operated.

Solar Aircraft Co., 2200 Pacific Highway, San Diego, Calif.

Infrared Cooler

Cryogenic cooler, utilizing liquid oxygen, liquid nitrogen or liquid air, is designed to cool Dewar-type infrared detector cells.

Model FW-22 cryogenic cooler will operate continuously for 22 hr. from filling or 16 hr. after 24 hr. standby. Consisting of a storage container and a transfer line cooling head, the unit utilizes natural pressure from thermal leakage or residual pressure of filling to force the cryogenic fluid from the container to the cooling head. The price for a single unit is: storage container—$500.00; transfer line—$400.00. Delivery time is 60 days.

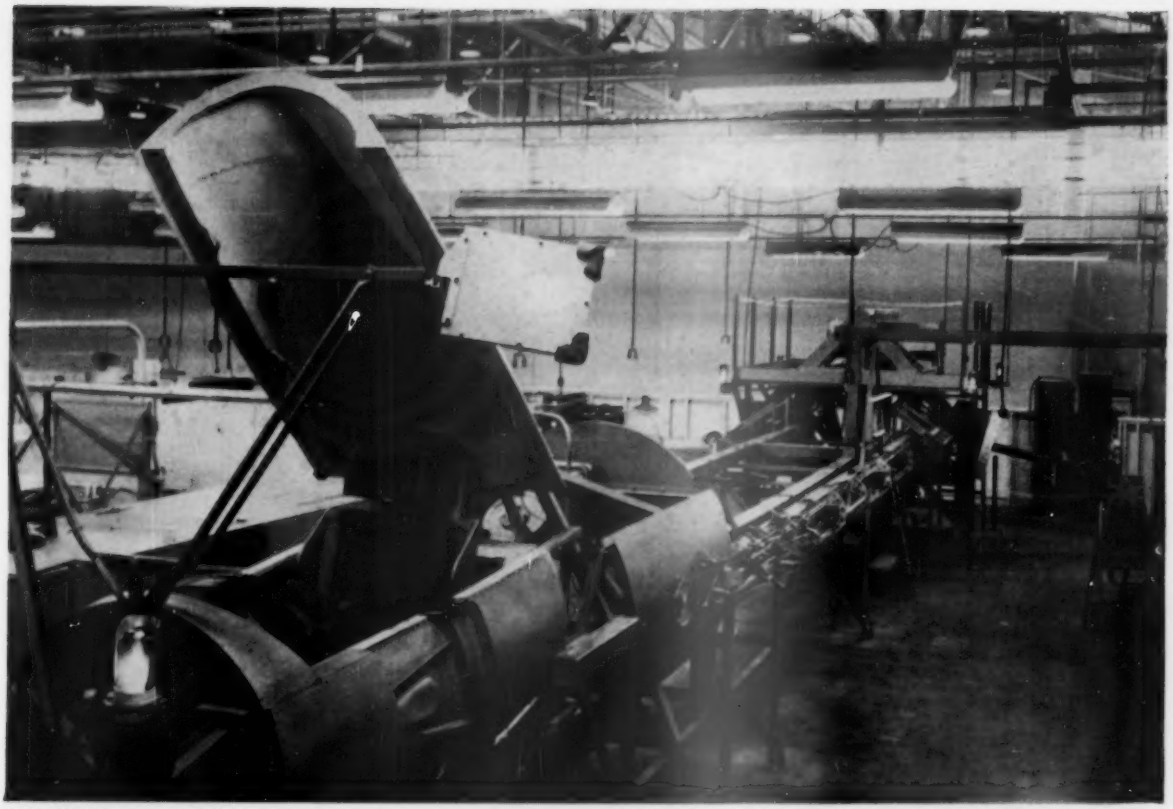
ITT Laboratories, Fort Wayne, Ind.

Cryogenic Pump

High-pressure pump for ground handling of cryogenic fluids including liquid hydrogen weighs 30 lb.

One to five modular pump assemblies may be employed to provide a range of from 2,000 scfh. to 75,000 scfh. of liquid gas to gaseous gas using either ambient air or water vaporizers. Maximum pressure is 15,000 psig. The pump has a net, positive suction-head requirement below 15 psig. at flows of 30,000 scfh. at 3,000 psig. discharge pressure. Either electric or hydraulic motors may be utilized to drive the pump.

Paul Chemical Co., Inc., 604 South Raymond Ave., Fullerton, Calif.



X-15 SIMULATOR includes a complete control system mockup complete with hydraulic system and using actual flight hardware. X-15 has no ailerons but uses differential elevator movement for roll control. In this case, the elevator is simulated by a large tube and weight shown at rear of mockup.

Simulator Provides X-15 Flight Regimes

By William S. Reed

Inglewood, Calif.—Extensive simulator training prior to actual flight was credited by X-15 pilot Lt. Cmdr. F. S. Peterson with providing the training which turned an emergency into a safe landing on his first flight.

Peterson experienced a premature shutdown of the XLR-11 engines because of a turbine overspeed while under what North American Aviation engineers describe as "the worst possible conditions." The X-15 was heading away from Rogers Dry Lake at Edwards AFB, Calif., at the maximum distance from landing point when the engines automatically shut down 80 sec. before burnout should have occurred. He later said that he had practiced this precise circumstance many times and later told NAA simulator personnel that executing the profile worked out on the simulator enabled him to make a safe landing on the lake.

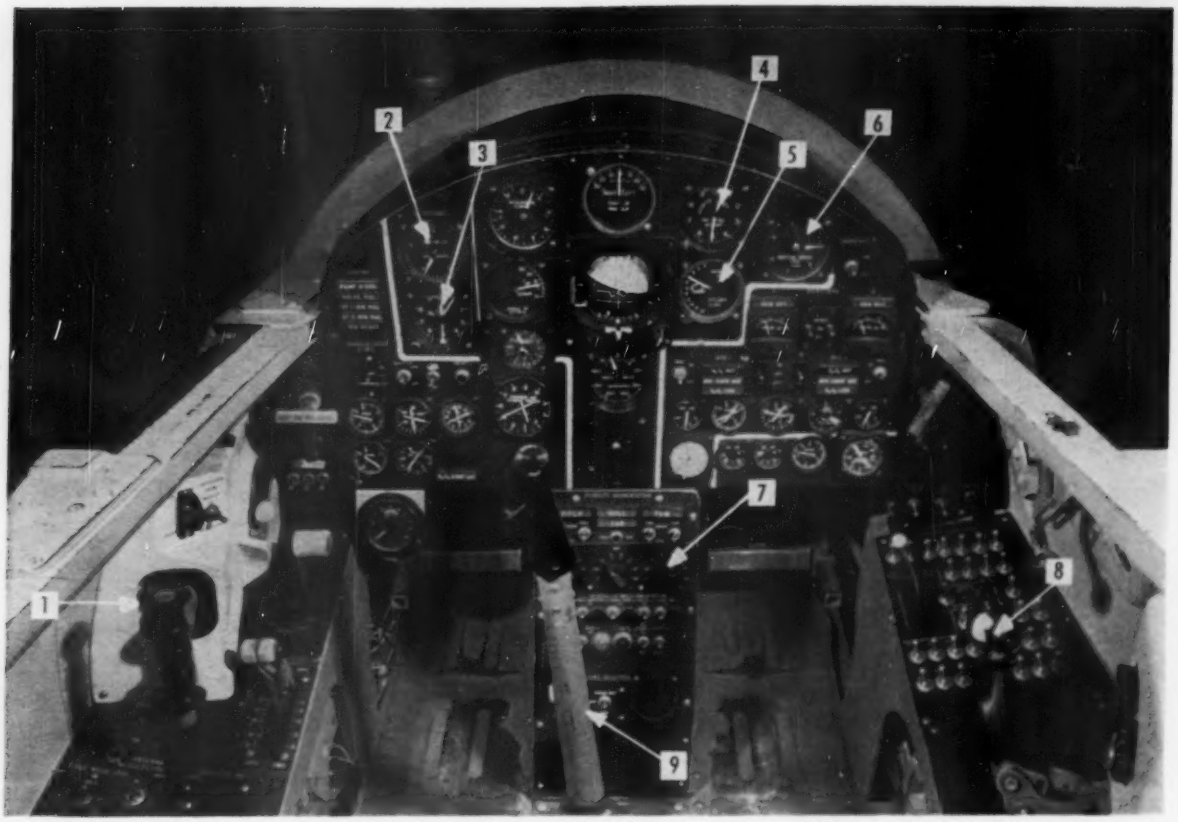
Flight control analysis group leader G. B. Merrick said that the simulator has grown along with the development of the aircraft and although the X-15 cockpit was not directly developed from the simulator, certain refinements in cockpit layout were tried in the simulator before going into the aircraft. Merrick estimates that NAA test pilot Scott Crossfield has spent between 500-600 hr. in the simulator for the few brief minutes of actual flying in the X-15 itself. No amount of simulator training can replace actual flight time though, Merrick admits, because the unknown quantities ascribed to "sweat, anxiety and adrenalin" cannot be incorporated into the computer by any known technique.

Control Factors

Aside from the relatively low speed, low altitude flights now being made with the interim engines, simulator training is used to provide experience with the difficult task of controlling the aircraft during forthcoming out-of-atmosphere flights. At altitudes of over 150,000 ft. up to the trajectory peak of 250,000 ft., reaction controls in the nose and wing tips will be used to maintain attitude.

Control will be exercised by the pilot through a handle operated with the left hand which is free to move in three directions—from side to side for yaw, up and down for pitch, and left or right rotation for roll control. During this portion of flight, the aircraft will behave as if it were neutrally stable, i. e., if a force is applied in one direction by one of the reaction jets, the aircraft will continue in that direction until an opposing force is applied. Result is that the aircraft will have a long period motion with slow reaction time.

Operation of the reaction controls is one area in which the simulator proves its worth. As tried by AVIATION WEEK in the simulator, maintaining a level attitude at a simulated altitude of 250,000 ft. is difficult, even without the sensory experience of weightlessness. The theoretical calculations derived by the engineers indicate that the X-15 will have to be controlled by a series of short blasts from the reaction jets rather than by smooth applications of control pressure. One outcome of the simulator tests is that with experience, a pilot can maintain a level attitude with fewer applications of the



COCKPIT instrumentation and controls include: (1) reaction control stick (2) pressure airspeed (3) altimeter (4) inertial altimeter (5) rate of climb indicator (6) inertial speed in ft./sec. (7) stability augmentation gains (8) side stick and (9) main control stick. Various settings on augmentation gain system allow pilot to select custom-tailored flight characteristics.

reaction controls than he can on the first run. Usually after a one hour practice session, a technique is developed which results in fewer control applications with correspondingly less expense of the hydrogen peroxide fuel which powers the reaction jets. Tankage for reaction control jet fuel has been cut to one half of that originally planned for the aircraft as a result of simulator experience.

Simulator Time

Capt. R. A. Rushworth, a Flight Test Center experimental pilot who will check out in the X-15 this month, told AVIATION WEEK that he will get from 12 to 20 hr. of simulator time immediately prior to his first familiarization flight. Rushworth already has spent many hours in the simulator and in the Johnsville, Pa., Navy centrifuge on other mission profiles, but the time he is getting prior to the first flight will all be devoted to the actual first flight profile.

Both pilot and flight test engineer go over the profile of a planned flight and seek out areas of poorest stability and large trim changes. These, together with simulated failures such as stability augmentation system malfunction, will be rehearsed by the pilot-engineer team. So far, comparison of the simulator traces with those data gathered from actual flights, has been most favorable. The trace of Peterson's flight with the premature burnout matched up almost exactly with similar traces taken from simulator flights.

Simulator flights are only practiced down to altitudes of around 5,000 ft. because the variables of flight in the denser atmosphere are not cranked into the computers. Practice from 20,000 ft. downward is gained by the X-15 pilots in a drag-configured Lockheed F-104 which has proved very valuable in simulating the X-15 lift-drag performance parameters.

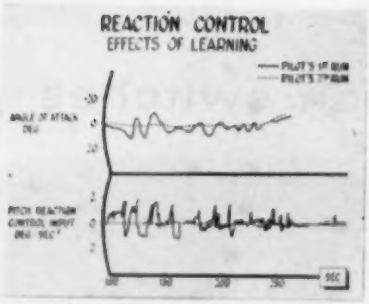
A typical high altitude profile mission as practiced in the simulator commences with the drop from the mother ship at 40,000 ft. at an airspeed of Mach .08. Thrust is started and the pilot makes an abrupt pull-up using 15 deg. angle of attack until a climb angle of 50 deg. is established. Pushover then is initiated to maintain a zero g trajectory for greatest altitude. Zero g is used because, among other factors, induced drag, or drag due to lift, goes to zero under these conditions. This technique also provides control of the exit path by establishing the initial trajectory angle, altitude and exit path.

During burnout, pitch and yaw control is required for thrust misalignment. Burnout occurs 90 sec. after launch at a velocity of 6,200 fps. (about Mach 6.7) and at an altitude of 160,000 ft. At this point, the effects of thrust misalignment are seen in oscillations in angle of attack and sideslip. Use of reaction control also begins at this altitude because of the loss of dynamic pressure resulting in loss of aerodynamic control.

Inertial Instruments

Mach number, rate of climb and altitude during the high altitude portion of flight are read by the pilot from separate instruments driven by an inertial platform since pressure reading instruments would be subject to gross errors at such extreme altitude. Inertial instruments are located to the right of the attitude gyro, pressure instruments to the left. Peak altitude reached is a little over 250,000 ft.

Recovery attitude consisting of a 15 deg. angle of attack is established at 200,000 ft. on the way down. Stabilizer is trimmed for 15 deg. nose up at any time before reaching 180,000 ft., while



TRACES taken from simulator runs show the effects of experience in learning to control the attitude of the aircraft with reaction controls. First try, superimposed on the seventh try, illustrates the lessening number of control inputs required after a pilot has had time to develop the technique.

attitude is maintained by the use of reaction controls.

Dynamic pressure begins to build up at approximately 180,000 ft., at which point effectiveness of the reaction controls is equal to that of the aerodynamic surfaces. The pilot allows the load factor to build up to about 5g and maintains this load factor until re-entry is complete. Results from the simulator have shown that there is no one prescribed technique to effect recovery and that, within limits, load factors and attitude can be varied and safe recovery still made. The X-15 is stressed for 7.33g and dynamic pressure of 2,500 psf.

The simulator has shown also that the aircraft can safely be controlled by the pilot during re-entry without the aid of the stability augmentation system.

Control System

To accomplish simulation, an extensive mechanization including actual control system equipment is used. A complete operational mockup of the flight control system provides system characteristics under operating conditions.

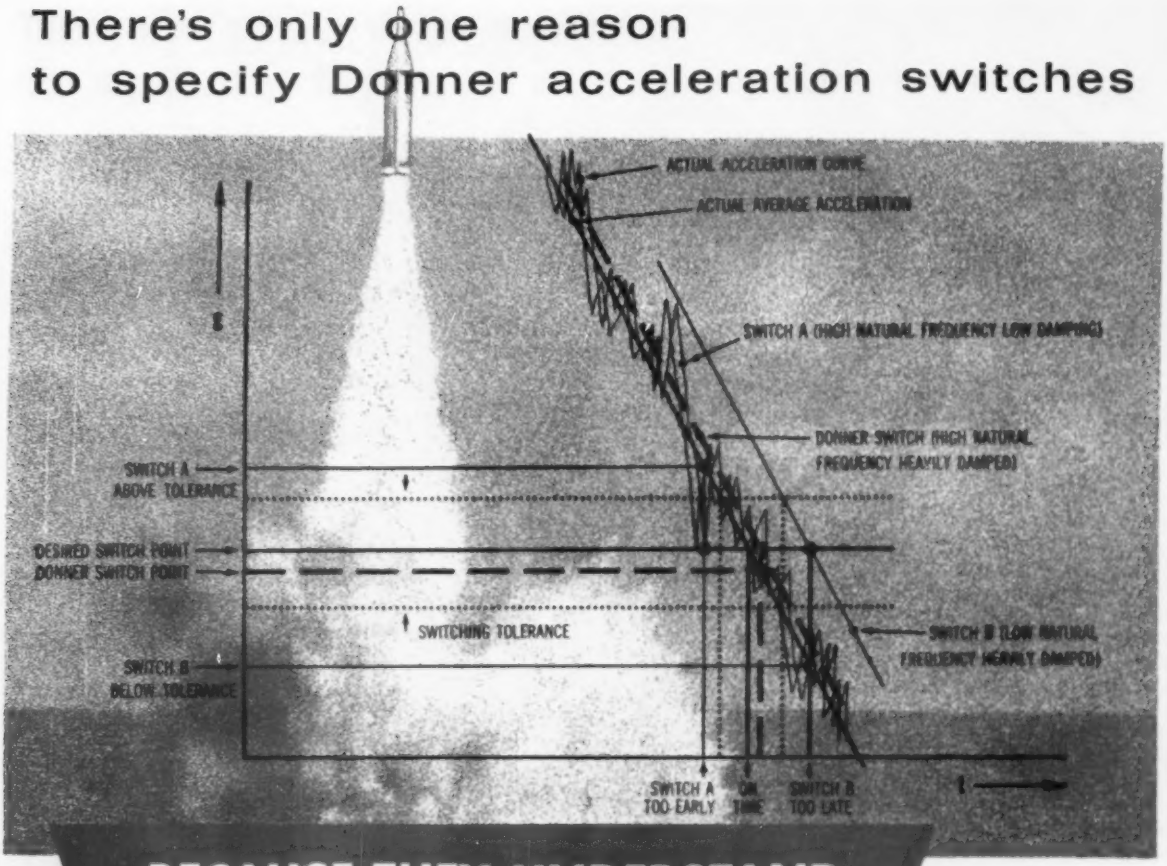
Actual flight hardware is used including cables, push rods, bell cranks, hydraulic system, artificial feel, etc., together with electronic equipments such as the stability augmentation system.

The aerodynamic six degrees of freedom equations are mechanized on analog computers which require 330 amplifiers, 35 computing servos and 70 arbitrary function generators. The non-linear variations of derivatives with Mach number are accomplished on special interpolating servos which provide 17 interpolating points for each of 16 parameters throughout the Mach range.

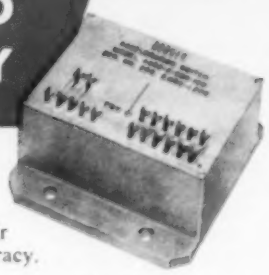
Non-linear variation of derivitives with angle of attack and other non-linearities are accomplished on diode function generators.

Grove Regulators assure dependable pressure control for propellant loading systems. This dependability is a direct result of Grove engineering leadership. Since the first rocket experiments 22 years ago, Grove has pioneered every basic design used in pressure regulators undersea and in outerspace.
GROVE VALVE AND REGULATOR COMPANY
A Subsidiary of Walworth
Oakland and Los Angeles, California

There's only one reason to specify Donner acceleration switches



..BECAUSE THEY UNDERSTAND THE MEANING OF ACCURACY



It's dynamic accuracy that counts. In truth, several firms make precision acceleration switches. But accuracy, like reliability, is a term with shades of definition. Some switches are accurate in the lab or on the test bench. That is, they provide *static* accuracy. Donner acceleration switches give you accuracy where it counts, on the operational missile. They are *dynamically* accurate.

Look at the graph above. Under static conditions, switch "A" with a better switching response, might be desirable. But suppose the missile were experiencing a 10 g vibration of a high frequency nature and proper thrust cutoff depended on detecting a 2 g switch point. Switch "B" would eliminate the problems of early switching, but introduce intolerable phase shift which in turn would make the switch "see" the event after it actually occurred. In other words, under the dynamic conditions of missile and aircraft flight, it is absolutely necessary to know when an event occurred rather than precisely where it occurred. Frequency response becomes a more important consideration than switch accuracy.

Heavily damped, with a high natural frequency, Donner acceleration switches have low phase shift providing the transient response necessary to follow rocket engine operation and perform their task with meaningful accuracy.

Donner Acceleration Switches are Flexible

Because of the inherent flexibility of Donner's basic accelerometer servo system and associated electronics, Donner acceleration switches will satisfy virtually any requirement.

Features include multiple switch points, any specified damping ratio, built-in time delays to overcome initial transients or delayed output, memory damping, and total programming capacity.

Six Page Brochure on Request—For complete technical information, write for our new brochure: Acceleration Switches for Accurate Determination of Thrust Termination in Missile and Satellite Vehicles. Please address Dept. 09.

DONNER SCIENTIFIC COMPANY
A Subsidiary of Systron-Donner Corporation
30 CONCORD, CALIFORNIA • MUlberry 2-6161

• Challenging career opportunities available for engineers and scientists.

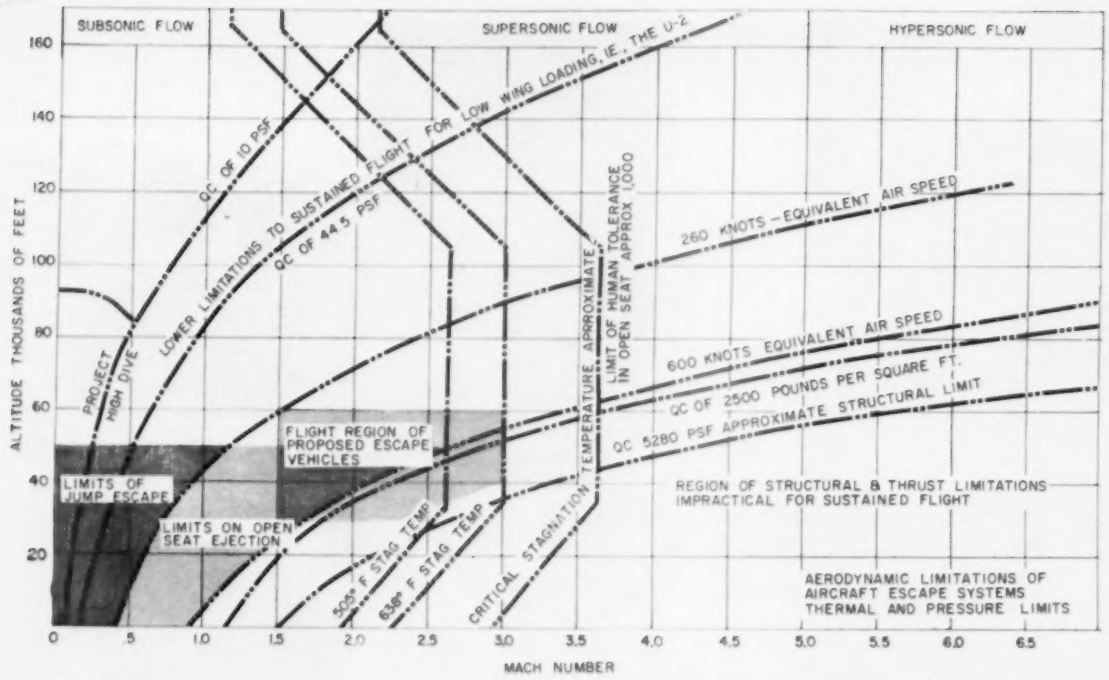

SUBSONIC FLOW
SUPERSONIC FLOW
HYPERSONIC FLOW
ALTITUDE THOUSANDS OF FEET
MACH NUMBER
QC OF 10 PSF
QC OF 44.5 PSF
LOWER LIMITATIONS TO SUSTAINED FLIGHT FOR LOW WING LOADING, IE., THE U-2
PROJECT HIGH DIVE
260 KNOTS — EQUIVALENT AIR SPEED
600 KNOTS EQUIVALENT AIR SPEED
QC OF 2500 POUNDS PER SQUARE FT.
QC 5280 PSF APPROXIMATE STRUCTURAL LIMIT
TEMPERATURE, APPROXIMATE LIMIT OF HUMAN TOLERANCE IN OPEN SEAT APPROX 1,000
FLIGHT REGION OF PROPOSED ESCAPE VEHICLES
LIMITS OF JUMP ESCAPE
LIMITS ON OPEN SEAT EJECTION
505° F STAG TEMP
635° F STAG TEMP
CRITICAL STAGNATION
REGION OF STRUCTURAL & THRUST LIMITATIONS IMPRACTICAL FOR SUSTAINED FLIGHT
AERODYNAMIC LIMITATIONS OF AIRCRAFT ESCAPE SYSTEMS THERMAL AND PRESSURE LIMITS

CHART shows approximate limits on aircraft escape systems and flight limits of aircraft. The "QC" is compressible dynamic pressure and is valid above Mach 0.3. High Dive curve marks limits of a jump from a high altitude gondola, using a stabilization chute.

Jumps Prove USAF Survival Concepts

By Larry Booda

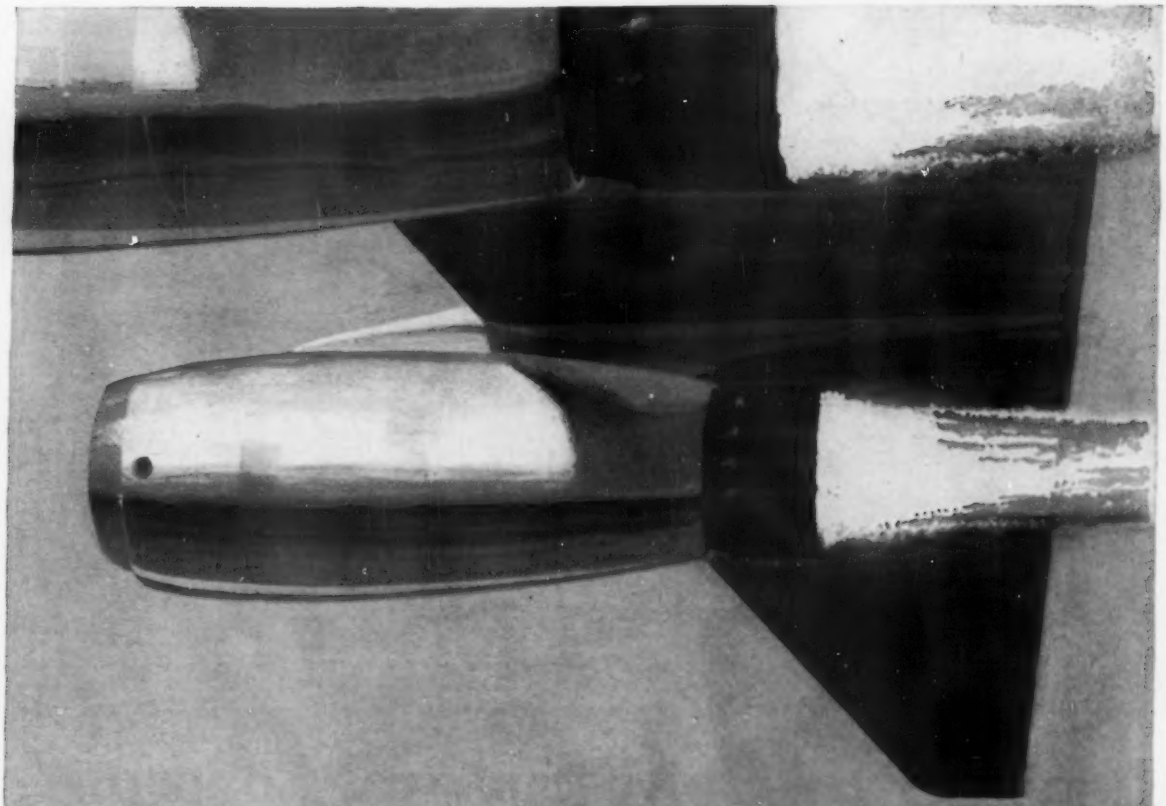
Washington—Capt. Joseph W. Kittinger's free fall and parachute jump from 102,800 ft. marked the climax of an Air Force research program designed to permit a crewman to escape unprotected from an aircraft or space vehicle flying high in the atmosphere.

Kittinger's jump, made over Holloman AFB, N. M. under Project Excelsior, proved survival concepts that apply primarily to escape from supersonic, high-altitude military aircraft, but they are also useful to pilots of such vehicles as the X-15, Dyna-Soar and Project Mercury capsule for escape below 100,000 ft. on their way to and from space.

Intensive efforts have been under way for some time by USAF, Navy and industry teams to provide reliable escape systems, mainly in the form of capsules, for these high performance vehicles. But flight surgeons feel that man himself must be the final consideration in any escape system because of the possibility that escape systems will fail.

Project Excelsior, which ended with Kittinger's 102,800 ft. jump, is the most recent of a series of high altitude parachute projects. It was an outgrowth of Project High Dive which was planned in 1952, but actual studies into the problem began in 1945 when the Lockheed P-80 jet aircraft went into pro-

PORTABLE cooler for X-15 pilots dressed in flight clothing is demonstrated by Capt. R. N. Richardson. Cooler was designed by Bendix Corp.'s Pioneer-Central Division.



Confidence counts **and the airlines count on Sinclair**

45% of the aircraft oil used by major scheduled airlines in the United States is supplied by Sinclair. Military jets also count on Sinclair to supply Sinclair Aircraft Oil to lubricate their mighty engines. There is no better proof of reliability.

Sinclair **AIRCRAFT OILS**

Sinclair

Sinclair Refining Company Aviation Sales, 600 Fifth Ave. • New York 20, N. Y.

duction. No longer could a pilot leave his aircraft with complete safety by simply diving over the side and opening his parachute. The ejection seat became the first escape device as a result.

Escape Systems

Some of the newer escape systems require the crewman to stay with his seat, which is stabilized by a small parachute or by fins, until a safe separation altitude is reached. For Mach 2-plus aircraft now in service, and for future aircraft, the pilot will ride a detachable capsule. In any case, the crewman eventually must leave most of the current designs, even the capsules, when he descends to a safe altitude—or at a higher, more hazardous altitude in an emergency.

As studies progressed in this country and England, it was determined that a free fall from high altitudes is mandatory before deploying the main parachute, for these reasons:

- **Parachute opening shock** might injure the man or damage the parachute at altitudes over 30,000 ft.
- **Extreme cold** of high altitude makes it imperative that a man fall to a lower altitude and warmer temperature quickly, reducing the chance of death or injury from cold or exposure.
- **Large oxygen supply** would be needed for a slow descent.
- **Slow descent** might result in death or injury from exposure to low atmospheric pressure.

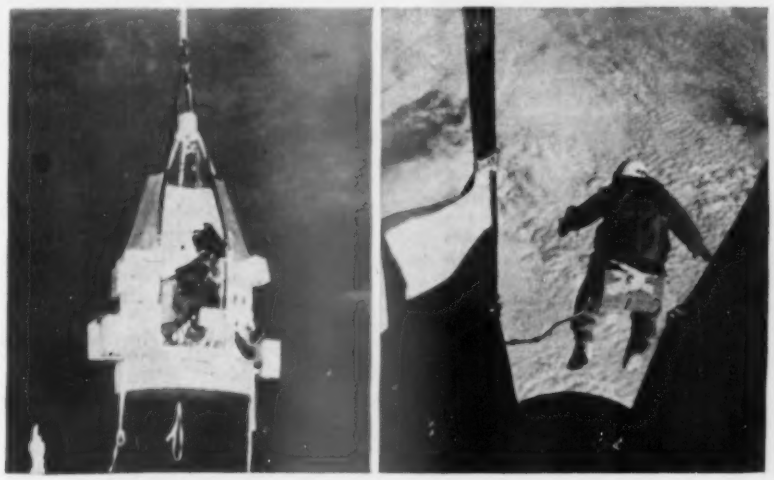
Center of the research effort in the U. S. is the Aero Medical Laboratory of the Wright Air Development Division at Dayton, Ohio. It soon became evident to researchers there that there was more to a free fall than simply jumping. Early experiments revealed that a human body tended to gyrate or spin, and if prolonged, this could cause damage to the brain or organs by pooling blood under pressure due to centrifugal force.

Impetus was given to the search for solutions to the problems encountered was provided in 1954 when Captains Edward Sperry and Henry P. Neilsen were ejected downward from a B-47 at 45,200 ft. They reported difficulty in controlling spins at that altitude.

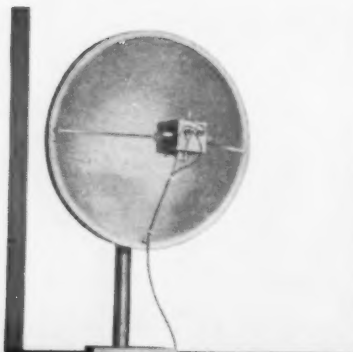
Dummies Used

It was determined that the safest way to approach the problem was by using dummies. By 1954, it was felt that equipment which had been developed in the laboratory at Wright Air Development Center was good enough to warrant undertaking a dummy and live jump program using a C-97 aircraft. This was followed by a program using dummies dropped from balloons. Phase I of the High Dive program consisted of unstabilized dummy drops, and Phase II involved

CAPT. Joseph W. Kittinger prepares for balloon ascent before jumping from 102,800 ft.



STABILIZATION chute was deployed 18 sec. after Kittinger jumped from the open gondola to keep him from spinning during his free fall to 18,000 ft., where the main chute opened.



GILFILLAN
MTI
CORNER
REFLECTOR

constant
monitor for
surveillance
accuracy

Provides Angle and Range siting calibration data for Long Range, Gap Filler and Ground Control intercept Radars.

The Gilfillan Moving Target Simulator reflects radar signals, when interrogated, back to the surveillance system at a constantly changing phase, during both normal and MTI operations.

The production unit includes parabolic reflector; waveguide assembly (containing a horn and transistorized diode switching circuitry); battery box. Waveguide assembly is furnished as S-band, X-band, or combination of both. S-band frequency range, 2.65 to 2.95 KMC, with effective radar cross section of 75 sq. meters and 10° (3db points) beam width. X-band frequency range, 8.5 to 9.6 KMC, with effective radar cross section of 640 sq. meters and 3° (3db points) beam width.

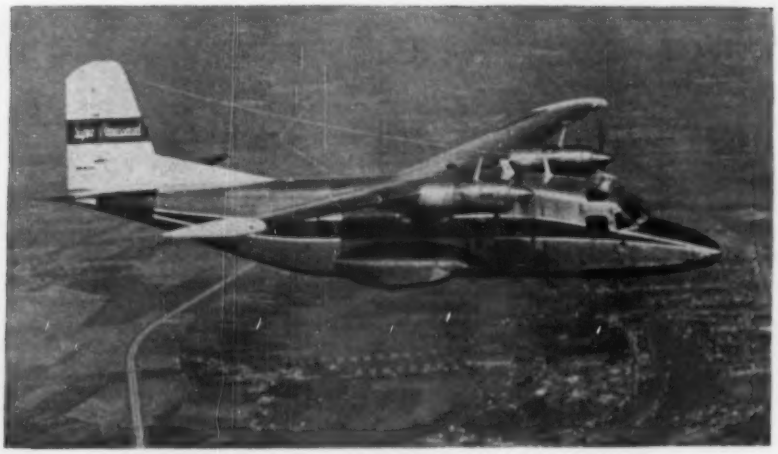
Pulses intercepted by the parabolic reflector are directed into the waveguide assembly, where they are phase-modulated (and to a small degree amplitude-modulated) by bias switching diodes. Switching frequency can be adjusted over a ratio of approximately 2 to 1, depending upon voltage of battery used.

Unique applications in L-band or other frequency bands as a research tool for the investigation of propagation paths or for commercial uses also available.

Send your requirements to:

Gilfillan

1815 Venice Boulevard
Los Angeles, California



Super Broussard Testing Continues

Max Holste Super Broussard twin turboprop transport has completed company test program and has been turned over to French government Flight Test Center at Bretigny. Plane is powered by two Turbomeca Bastan engines of 1,000 hp. on takeoff (AW Aug. 15, p. 43).

stabilized dummy drops. The site chosen for the drops was Holloman AFB, primarily because of good weather conditions. Between 1954 and 1957, 56 dummy drops were made at Holloman. The first 35 drops were made from a C-97 aircraft flying at altitudes ranging from 25,000 to 31,000 ft. at indicated airspeeds between 160 and 175 kt. These aircraft drops were made principally to test equipment, but it was observed that the dummies spun up to 102 rpm.

In the balloon phase, polyethylene balloons were used—mainly the Winzen and General Mills TT models. These balloons were chosen because they were capable of lifting the necessary payload, and they could do it economically because two dummies could be carried to altitude at one time, achieving a saving over smaller balloons carrying one dummy per balloon.

Multi-Stage Chutes

In the 21 balloon drops made at altitudes up to 91,000 ft., spins reaching to 200 rpm. were recorded. By early this year, drop tests using multistage parachutes were being made with dummies. Eighteen drops were made from balloons between 68,000 ft. and 102,000 ft. in January and February, and some 120 drops have been made since then.

Dummies used were anthropomorphic, with controlled movements of limbs. Dummies resembled a man with a height of 72 in. and a weight of 200 lb.; weight distribution and body configuration were very similar to those of an average man of relatively large stature.

Each dummy was equiped with one N-6 GSAP gun camera exposing 16 mm. color film; 11 recording accelerometers (eight in a survival-type kit and three on the back), one 14 channel Century Model 409 oscillograph with 11 channels receiving transmissions from the accelerometers, one serving as a voltage trace and two recording time-reference blips; 18 HR-1 Silvercel batteries which supplied power to fire the explosive cut-down Squibs which cut the dummy down from the balloon, run the camera and oscillograph and furnish voltage for the acceleromotors; one modified Brailsford timer to sequence cut-down and operate a latching relay, and one g-proof latching relay to turn on the recording instruments, and, after the free fall was completed, turn the power supply off.

With the exception of the three accelerometers on the dummy's back, all the instrumentation was contained in a survival-type kit attached to the saddle of the parachute harness with two quick release clamps. At a preset altitude, the timer activated the clamps, and the kit would descend by its own parachute.

The balloon instrument box, which initiated the cut-down, contained its own power supply, a command radio receiver, a mechanical clock cut-down system to override radio command failure, a barometric safety device which would cut the dummy down automatically if the balloon rose above 30,000 ft. then started to descend. This balloon cut-down box carried an 18-24 ft. unpacked parachute which hung below the balloon.

A typical mission profile, greatly simplified, included a long check list on instrumentation, positioning and dressing of the dummy, transportation to the launch area, weighing, attachment to the balloon, setting all instru-

McGRAW-HILL BOOK NEWS

NOISE REDUCTION

Just Published. Nineteen experts discuss the theoretical and applied aspects of noise-reduction, and help you more fully understand developments in the field. The book presents a unified approach to such aspects as selection of instruments for reliable measurement . . . sound—propagation indoors and outdoors . . . criteria for noise and vibration in buildings and vehicles . . . sound transmission through walls . . . and much more. Provides a wealth of charts, diagrams, and worked-out examples—with frequent comparisons made between measured and calculated data. **Edited by L. Beranek, Pres., Bolt Beranek and Newman, Inc. 752 pp., 399 illus., 61 tables, $14.50**

INFRARED RADIATION

Just Published. Explains exactly what infrared radiation is and what it does. Analyzes a typical infrared system and discusses the components of such a system, the laws of physics by which it operates, and the materials involved. Clearly describes the limitations, the problems encountered, and the scope and future possibilities of infrared applications. **By Henry L. Hackforth, Nortronics, Div. of Northrop Aircraft. 303 pp., 172 illus., $10.00**

SPACE FLIGHT

A thoroughly scientific, highly readable account of satellites, spaceships, space stations and space travel. Shows the contributions to astronautics of such fields as astrophysics, communications, geophysics, materials, space medicine, and chemistry. Dr. Wernher von Braun says of this book, ". . . it will soon attain the stature of one of the few great classics on this fascinating and many faceted subject." **By Carsbie C. Adams, National Research & Development Corp., 364 pp., 50 illus., $7.00**

MISSILE AERODYNAMICS

Just Published. Explains principles of missile aerodynamics, treating such subjects as bodies, wings, and tails, and interaction between them which are of particular importance to missiles. Gives methods for determining airflow about missiles, and a full account of drag, including the effects of viscosity. Also covers stability derivatives and aerodynamic controls. While the material covered is directed at the supersonic speed range, most of it is also applicable to subsonic speeds. **By Jack N. Nielsen, VIDYA, Inc. 431 pp., 213 illus., $12.50**

10 DAYS' FREE TRIAL • SEND COUPON

McGraw-Hill Book Co., Dept. AV-10-17
327 W. 41st St., New York, 36, N. Y.

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

- ☐ Beranek—**Noise Reduction**—$14.50
- ☐ Hackforth—**Infrared Radiation**—$10.00
- ☐ Adams—**Space Flight**—$7.00
- ☐ Nielsen—**Missile Aerodynamics**—$12.50

Name .....
Address .....
City ..... Zone .... State .....
Company .....
Position .....

For price and terms outside U.S. write McGraw-Hill Intl., N.Y.C. 36 AV-10-17

ments, balloon inflation, and launching. On reaching altitude, the dummy was cut down by radio command. At 15,000 ft., the main personnel parachute deployed and the instrument kit was released. Recovery crews were directed by spotting aircraft and by radio direction finding posts.

Test Results

It became apparent from the results of these tests that no man could be expected to make a free fall without some form of stabilization from high altitude without a very strong possibility of severe spinning and tumbling which would cause injury or death, either directly or indirectly.

This led to successful research in stabilizing system and a series of test jumps by Capt. Harry Collins and Master Sgt. George A. Post. A series of about 20 jumps were made from C-97s, C-119s and B-50s flying at low speed. These High Dive test jumps were suspended when researchers found they couldn't make the stabilization chute they had developed deploy with a static line. After further research, the jumps were resumed by Kittinger under the new name of Project Excelsior.

Kittinger made his first Excelsior jump from the record height of 76,400 ft. on Nov. 16, 1959. He made a second jump from 74,700 on Dec. 11, 1959, and the third from 102,800 ft. Aug. 16, 1960. He won the Harmon Trophy for his 1959 jumps, and the record jump last August won him the Distinguished Flying Cross.

Kittinger's jumps were made from a balloon-borne open gondola. He also has participated in high altitude research in a sealed gondola under Project Man High, reaching 96,000 ft. Lt. Col. David Simons and 1st Lt. Clifton McClure also made sealed gondola flights to the 100,000 ft. level under this program.

Gondola Design

The open gondola used in Excelsior appears superficially to be a throwback to the early days of free ballooning because it is an open basket with an open doorway. Closer examination reveals modern construction. It is 4 ft. 6 in. in diameter and weighs 800 lb. It is constructed of tubular steel with an aluminum skin. Over the top is a teepee-like arrangement of aluminized cloth to reflect the sun's rays.

It was fabricated by the Engineering Shops at Wright-Patterson AFB in accordance with design drawings furnished by the Aerospace Medical Division and drawn in detail by the Modification Division.

Outside the gondola is a wet cell

NORD-AVIATION
Ordnance
Research
Development

CT-20 TARGET DRONE
SIX RECOVERABLE FLIGHTS

Nord's CT-20 is zero length launched and radio controlled. These drones have averaged six flights, recoverable in the sea as well as on land. Simplicity of design and operation, plus maximum re-use, represent cost savings.

MAIN CHARACTERISTICS

Speed at 32,800 ft.	**560 m.p.h.**
Time to 32,000 ft.	**6 min.**
Mean endurance	**45 min.**
Service ceiling	**40,000 ft.**
Take-off weight	**1,470 lbs.**
Span	**11.15 ft.**
Length	**17.71 ft.**
Diameter of fuselage	**2.16 ft.**
Wing area	**34.34 sq. ft.**

NORD-AVIATION

2-18, rue Beranger
CHATILLON-SOUS-BAGNEUX
(Seine) France

Which of these Craig skills and services can help you?

- **Systems housing** — light weight, high strength aluminum shelters, vans and trailers.
- **Systems components** — telescoping antenna masts, transit cases, cabinets, equipment racks.
- **Systems installation service** — layout and installation of transportable systems, through final checkout.
- **Systems packaging research** — engineering design and development for ground support and electronic equipment protection.
- **Complete production facilities** — to handle your complete packaging assignment.
- **A unique "aluminum-chemical research" service** — engineering "brainpower pool" for solving virtually any problem in aluminum and foamed plastic fabrication.

WRITE TODAY FOR CRAIG'S CAPABILITIES BROCHURE

Craig SYSTEMS, INC.

Dpt. BI2, 360 Merrimack St., Lawrence, Mass. - Tel. MUrdock 8-6961

Business systems and equipment are another Craig specialty through LeFebure Corporation, Cedar Rapids, Iowa — a Craig subsidiary.

battery weighing approximately 75 lb., which furnishes all the power for the electrically heated clothing, radios, cameras and other equipment. It is a standard aircraft lead-acid (Mil spec. Mil-B-6147) battery with an unprotected weight of 56 lb. It is protected by 18 water bottles next to the battery with an outside wrapping of styrfoam and cardboard. It was chamber tested to 100,000 ft. and to temperatures as low as −100F for periods of 12-24 hr. In actual operation, there was some boil-off of the electrolytic but not enough to affect performance for short periods of time and at low current rates.

A liquid oxygen converter supplies enough oxygen for more than the 1.5-2 hr. normal flight. It has a five liter capacity and is manufactured by Bendix Corp.

An instrument panel has two altimeters, one for below 60,000 ft. and one for above 60,000 ft.; a vertical climb indicator; a liquid oxygen quantity gage; a helmet pressure gage; gondola temperature thermometer; on-off switches for the electrically heated socks, gloves, and helmet facepiece.

Also inside the gondola are UHF and VHF transceivers. One is used for voice transmission and the other for telemetering of heart beat, respiration, etc. Cut-down systems for the gondola include a timer set for one hour longer than the expected flight, and command cutdowns, set off by ground stations.

The jumper wears a partial pressure suit, the MC-3 PP with MA-3 helmet, which allows the wearer to move more freely than he could with a full pressure suit, but still restricts movement so that only the hands and arms can move with any freedom and the head is virtually immobile. To provide for this lack of head mobility, a mirror on a swivel arm permits the jumper to observe all parts of the gondola—even under the seat and above to the hook-on to the balloon.

Under his partial pressure suit, Kittinger wore a winter-type, two-piece suit of long underwear, and next to the skin, a two-piece waffle weave cotton under-garment. Electrodes were taped to his skin to record heart beat and respiration. He wore cotton socks covered by pressure socks and a pair of electrically heated wool socks, wool socks and insulated "Li'l Abner" boots. On his hands he wore rayon glove inserts, pressure gloves, electrically heated flying gloves and a muff.

An instrument kit camera recorded the rotation frequency and direction of jumper rotation. It is a Century Engineers, Inc., Burbank, Calif., 16 mm. motion picture camera with a 100 ft. capacity, Model GA-1-C1. It was modified by the Optical Instrumentation Section, Test Data Division, Flight and Engineering Test Group, WADD. Size was reduced and frame speed reduced from 64 frames per second to 12 frames per second. Shutter opening was changed to 10 deg. and a timing light installed for instrument correlation.

Instrument Panel Camera

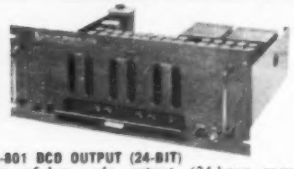
The instrument panel was recorded by a single frame 35 mm. camera with a 21 ft. capacity. It is Model Mk. 3 manufactured by D. Shackman & Sons, England. Distributed in the U.S. by J. A. Maurer, Inc., it was pulsed for one frame per minute. An identical camera photographed the jumper's head and shoulders during ascent.

As the jumper fell away from the gondola, a 70 mm. sequential aircraft strike attack camera, Model P-2, manufactured by J. A. Maurer, Inc., using a 76 mm. lens, operated at six frames per second and was stopped by an automatic timer. An identical camera, but with a six inch lens, recorded the jumper as he dropped farther away from the gondola. Recording the jumper from overhead before his exit was a type N-6 Bell & Howell motion picture 16 mm. gun camera, operating at 16 frames per second. It was actuated by the jumper moving from his seat. Three of these cameras also recorded the jumper as he fell away from the gondola. Fitted with lenses of varying focal lengths, they were actuated by the

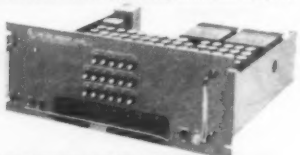
TIME TEAM

HOW EECo'S ALL-STAR LINEUP OF TIME CODE GENERATORS WINS ON EVERY POINT

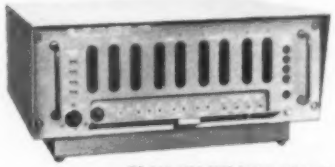
Look at these unparalleled advantages offered by EECo Time Code Generators! Frequency stability, 3 parts in 10^8, based on extremely stable crystal oscillator. 100% plug-in circuits to keep generator working for you day in and day out. Emitter-follower low-impedance outputs for long-distance transmission. Wider operating-temperature stability. Operable from aircraft power. Provision for external frequency standard. Human-engineered. Check it all out and you must choose EECo!



ZA-801 BCD OUTPUT (24-BIT)
Time-of-day code output (24-hour recycling) and any 2 of 8 pulse rates. $7,650.
ZA-803 BCD OUTPUT (20-BIT) $7,925



ZA-802 BINARY OUTPUT (17-BIT)
Time-of-day code output (24-hour recycling) and any 2 of 8 pulse rates. $7,050.



ZA-810 100 PPS CODE (36-BIT)
ZA-810-M1 IRIG TYPE C (23-BIT 2-PPS CODE)
Day-of-year plus time-of-day. Proposed Inter-Range Instrumentation Group formats. ZA-810 used by NBS on WWV. Either model, $11,180.

SEND FOR TIME CODE GENERATOR FILE 301

Electronic Engineering Company *of California*

1601 East Chestnut Avenue • Santa Ana, California • Kimberly 7-5501 • TWX: S ANA 5263

EE G-14

jumper. They operated at 32 frames per second.

The launch was recorded from the gondola by a GA-1-C1 16 mm. 100 ft. capacity motion picture camera manufactured by Century Engineers, Inc., Burbank, Calif. They were started by the jumper and operated at 32 frames per second.

The balloon for the record jump was designed by Cambridge Research Center and manufactured by General Mills, Inc.

Made of polyethylene panel construction with heavier weight-carrying seams between the panels, its capacity was 2.9 million cu. ft. of helium.

The multistage parachute assembly is composed of a harness and pack, standard USAF B-5 modified; canopies are a standard pilot canopy, an experimental 6 ft. stabilization canopy and a modified standard (C-9) 28-ft. dia canopy.

The first and second stages operate on time release principle. The third stage release operates on both an aneroid and time principle; for example, aneroid setting of 18,000 ft. and two seconds. Prior to gondola exit, the jumper arms the first and second stages and immediately makes his departure. Eighteen seconds later, the first stage, or pilot chute, deploys and extracts the second stage parachute, which is the six foot stabilization chute. Ten minutes after the jump, a radio command cuts the balloon away and the gondola descends via a parachute. In all the jumps most of the equipment is recovered, and only the balloons are expendable.

Upright Position

Deployment of the stabilization chute places the jumper in an upright position throughout his descent. He can make turns by extending one leg or the other about six inches. At 18,000 ft., the C-9 pilot chute deploys, followed immediately by the main parachute.

The 57 lb. instrument kit is jettisoned by the jumper at 5,000 ft., and it descends via a 16 ft. cargo parachute. This instrument kit contains transistorized circuitry to monitor pulse rate, electrocardiogram, respiration, voice and time, plus a tape recorder, power supply and camera.

During the actual descent from 102,800 ft., this kit was not released because Kittinger had suffered a swollen right hand when the right glove pressurization failed as he ascended. As a result, he couldn't release the kit and the extra weight made him land harder than expected, but with no ill effects.

Kittinger said the wind information given him before his record-breaking flight was so precise that he landed 50 ft. from the predicted point of landing. During his descent, he went through a cloud layer whose tops were at 21,000 ft. and bases from 12,000 to 15,000 ft.

The new Cherry "9000" Series MS type rivets are now a part of our standard product line, along with our familiar knob stem rivets.

Cherry is again FIRST to provide grip markings on the rivet head—for easy identification in bins or work boxes, plus positive visual inspection after installation.

Meeting fully the requirements of MIL-R-7885A, the new Cherry "9000" Series rivets are available in your choice of metals, and are installed with existing serrated stem pulling heads.

For those who prefer serrated stem type blind aircraft rivets, the Cherry "9000" Series completes the line which includes the new Cherrylock "2000" Series Mechanically Locked Stem with flush fracture, the Cherry High Clinch Series rivets—"600", "700", "800"—and the Cherry Standard MS line of knob stem rivets—the "100" and "500" Series. For information write: Cherry Rivet Division, Townsend Company, Box 2157-N, Santa Ana, Calif.

CHERRY RIVET DIVISION
SANTA ANA, CALIFORNIA
Townsend Company
ESTABLISHED 1816 • BEAVER FALLS, PA.
In Canada: *Parmenter & Bulloch Manufacturing Company, Ltd., Gananoque, Ontario*

WHAT WAS SINGER DOING AT PORT WASHINGTON? At this important U. S. Naval Training Device Center, the Navy is solving a basic problem in today's design engineering: how to accommodate complex electronic equipment to the performance capabilities of a human operator. Human engineering specialists of the Singer Military Products Division worked with Navy research teams to develop fundamental design principles for electronic apparatus. The aim: practical maintainability by the average technician. The result was a manual titled *Maintainability: A Guide to the Design of Electronic Equipment.* A division of The Singer Manufacturing Company, SMPD is composed of Singer-Bridgeport, Diehl Manufacturing Company and HRB-Singer.

A comprehensive brochure describing SMPD *engineering and production facilities is yours for the asking.*

SINGER MILITARY PRODUCTS DIVISION

The Singer Manufacturing Company 149 Broadway, New York 6, N. Y.

SINGER-BRIDGEPORT • DIEHL • HRB-SINGER

SINGER®

2169

*A Trademark of THE SINGER MANUFACTURING COMPANY

Rotor Platform Proposed for Data Relay

By Michael Yaffee

New York—Versatile, ramjet-powered rotor platform which will hover at 100,000-ft. altitudes is now being proposed for Signal Corps data relay mission. The vehicle will relay microwave transmissions from low-flying surveillance drones to remote ground receivers.

The unit, now under development by U. S. Industries, Inc., will also be proposed for application in a mobile Minuteman communication system, in anti-field ballistic missile systems (AW Oct. 10, p. 27), as a self-contained early warning and surveillance vehicle, as a command guidance and navigation unit and as a meteorological and scientific observation platform.

USI expects to have a seven-foot rotor (¼ scale) model of the platform ready for tie-down tests in early 1961 and says it could have a full-scale ram rotor unit ready for flight tests within 36 months of receipt of a contract together with the associated ground equipment and guidance.

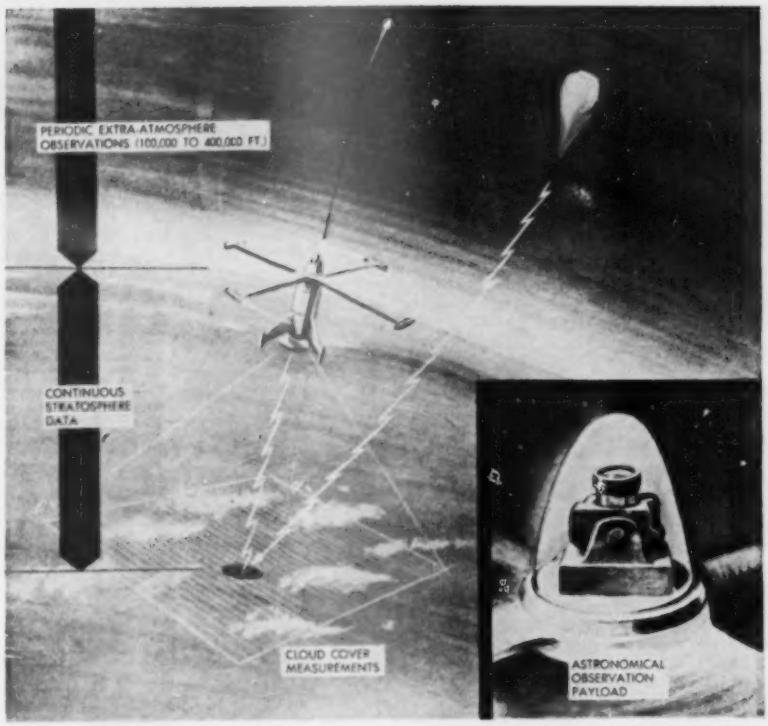
The full-scale units, according to present plans, will be 19 ft. tall and have a rotor diameter of 35 ft. Early vehicles will probably have subsonic rocket rotors capable of raising 50-lb. payloads to hovering altitudes of 60,000 ft. Hover duration will probably be 15 min. Later platforms will go to supersonic rocket and ram rotors and will be capable of raising 200-lb. payloads to hovering altitudes of 80,000-100,000 ft. for periods up to one hour.

Other Approaches

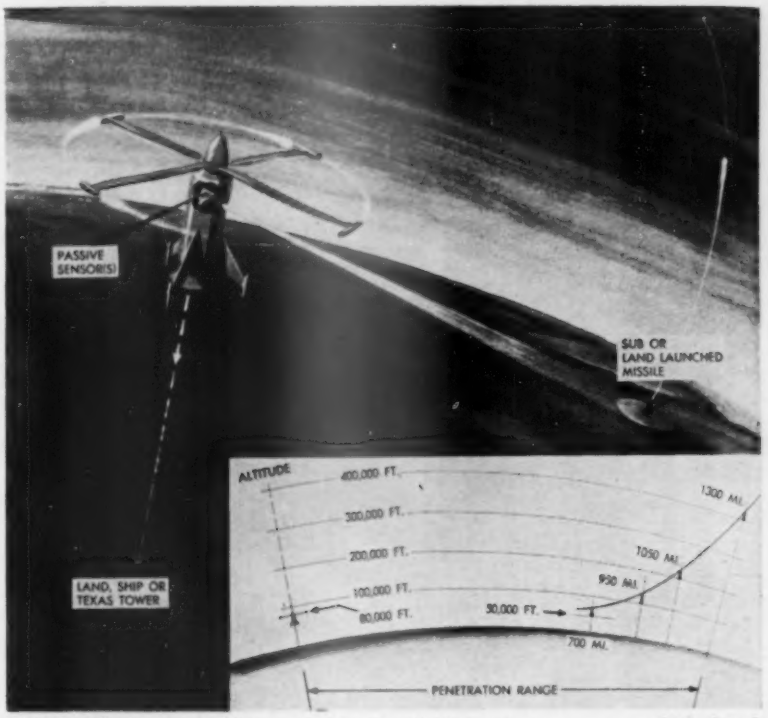
At the present time, USI's stratosphere rotor platform reportedly is one of the approaches under serious consideration by the Army Signal Corps as a high-altitude relay vehicle to be used in conjunction with the Army's SD-4 or SD-5 surveillance drones. Some other approaches are believed to be circling drones, unmanned radio-controlled helicopters and balloons.

In January, 1959, when the Army first asked USI and a number of other companies for ideas on a drone real time relay station, the requirements listed were for a station-keeping vehicle that would be capable of flying at 100,000 ft. and of relaying data from a low-altitude surveillance drone having penetration ranges up to 500 miles. The vehicle, of course, would have to stay up long enough and have adequate payload capability to work with the drone. The Army specified it was not to be a satellite.

In response to this informal solicitation, the Army received a number of proposals but was unable to come up


PERIODIC EXTRA-ATMOSPHERE OBSERVATIONS (100,000 TO 400,000 FT.)
CONTINUOUS STRATOSPHERE DATA
CLOUD COVER MEASUREMENTS
ASTRONOMICAL OBSERVATION PAYLOAD

FITTED out with proper payload, the stratosphere rotor platform might be used for continuous cloud cover surveys, upper air sampling, radiation and wind velocity measurements and other similar data.

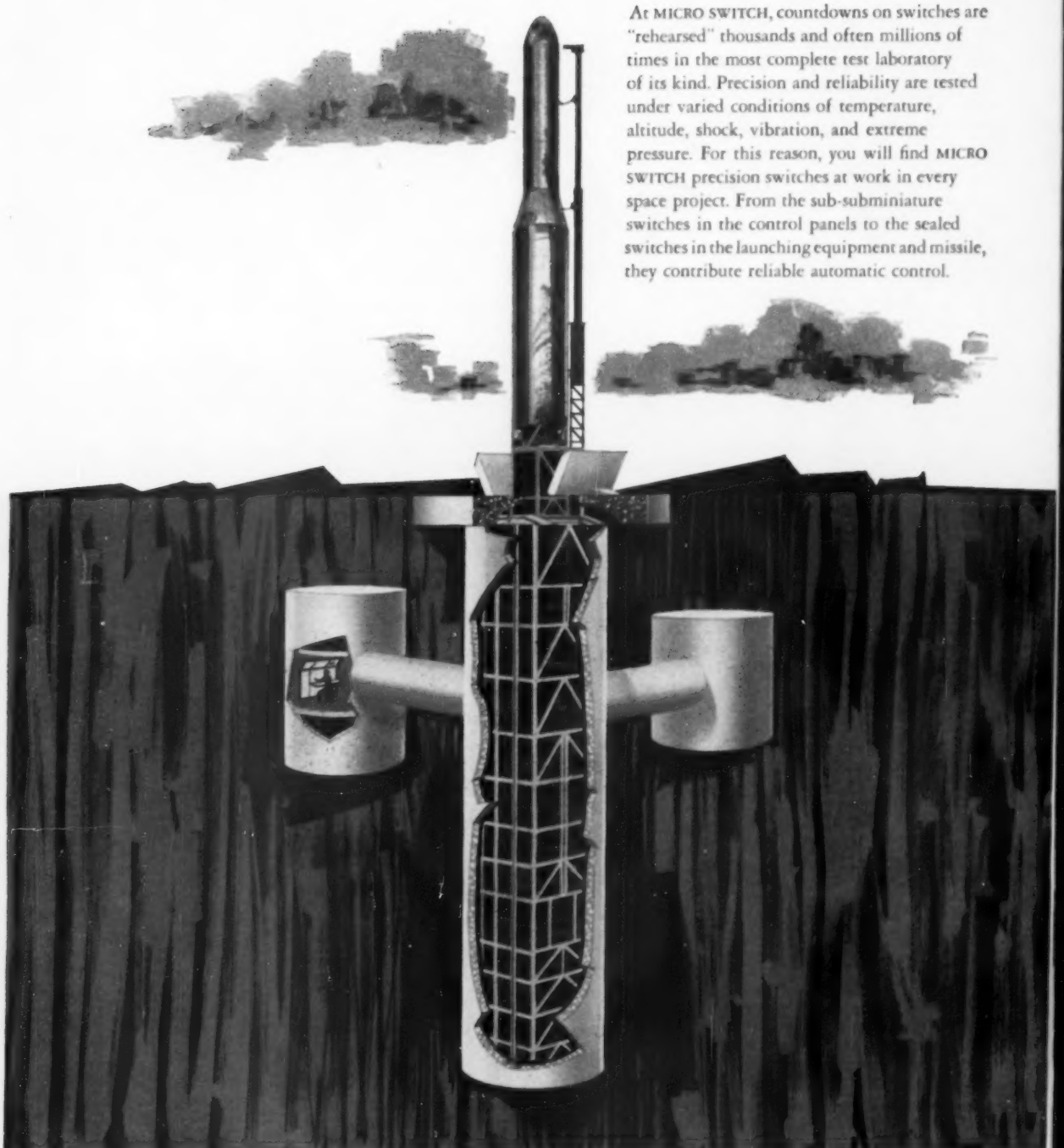


STRATOSPHERE rotor vehicle, equipped with suitable sensors, can serve as a high altitude early warning and surveillance platform, according to U. S. Industries.

*A TRADEMARK OF THE SINGER MANUFACTURING COMPANY

MICRO SWITCH Precision and Reliability Are Thoroughly Proved When

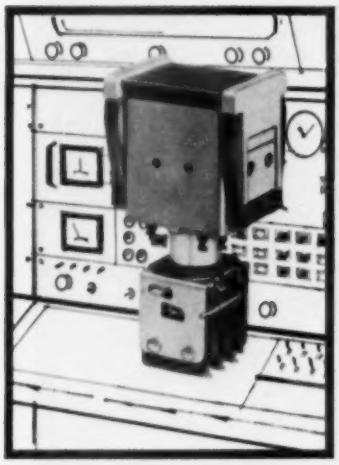
Switches go to work

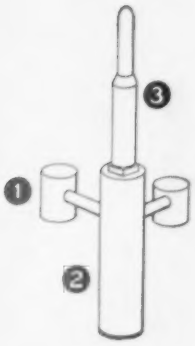


At MICRO SWITCH, countdowns on switches are "rehearsed" thousands and often millions of times in the most complete test laboratory of its kind. Precision and reliability are tested under varied conditions of temperature, altitude, shock, vibration, and extreme pressure. For this reason, you will find MICRO SWITCH precision switches at work in every space project. From the sub-subminiature switches in the control panels to the sealed switches in the launching equipment and missile, they contribute reliable automatic control.

MICRO SWITCH Precision Switches

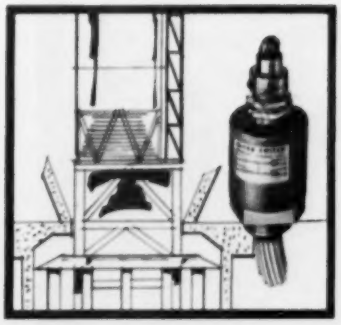
at Countdown!





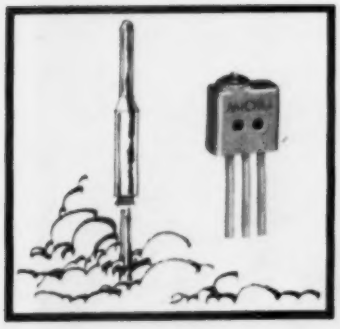
1 GROUND SUPPORT CONTROL

MICRO SWITCH "Series 2" Lighted Push-Button Switches meet the very latest requirements in the field of Human Engineering. Their modular design permits complete flexibility in the arrangement of visual indicators on the control panel. Behind the panel they can be connected to an infinite number of switch combinations. "Series 2" switch modules simply snap together to fit your design requirements, then snap into slots in the mounting panel—all without tools. Write for Catalog 67.



2 LAUNCHING

MICRO SWITCH "EN" Series and "HR" Series switches perform automatic control and signal functions during launching. They are sealed against the elements, making them completely reliable on outside gantry locations. Their shock-resistant design makes them suitable for use in explosion areas. They can be adapted to many different applications through their wide selection of actuators. Write for Catalog 77.



3 MISSILES

The new Sub-subminiature "XE" Switch is an environment-sealed switch, yet is smaller than a dime. It was developed by MICRO SWITCH to make possible a 30% savings in size and a 20% savings in weight over any previous environment-sealed snap-action switch, while still maintaining the same electrical rating. The "XE" is typical of new switches for missiles and advanced aircraft applications that give MICRO SWITCH unmatched experience. Write for Data Sheet 169 on the "XE" or Catalog 78 which describes many other sealed switches for these applications.

The nearby MICRO SWITCH Branch Office can make engineering help promptly available for particular switch problems. See the Yellow Pages for the address.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

75 YEARS HONEYWELL PIONEERING THE FUTURE

Honeywell
MICRO SWITCH Precision Switches

CREATING NEW DIMENSIONS

IN METALWORKING

FORGINGS BY ARCTURUS

Using highly advanced techniques, Arcturus is creating precision forgings that pace our expanding technology . . . forging difficult configurations to meet the most critical industrial and military requirements. Arcturus solutions to your metalworking problems will meet your design criteria, drastically reduce machining time, increase the strength of the finished part. Our 25,000 pound steam drop hammer is the largest in the west — we work with most metals and high temperature alloys. The next time you have a critical metalworking problem — from a thin walled turbine wheel to an industrial fitting — investigate the forging capabilities of Arcturus. Write for our brochure, Forging Ahead With Arcturus.

Arcturus

MANUFACTURING CORPORATION

4301 Lincoln Boulevard, Venice, California — Phone UPton 0-2751

with money to fund them. Although the Army still has not been able to obtain the money needed to fund this program, it reportedly hopes to have the money in FY 1962 with some chance that funds still may be found in the FY 1961 budget. Interest in the program is still very much alive, with the companies such as USI keeping a close watch on potential changes in the project's requirements or funding situation.

Meanwhile, a second potential application for the USI strato platform materialized out of the Air Force requirement for communication systems to link its mobile Minuteman launching platforms. USI went to USAF with the suggestion that the strato relay platform could be used either as emergency supplement to the telephone and microwave systems or as a substitute for the microwave system. Two strato platforms could cover a distance of 1,600 mi., according to USI; and four would cover the country, doing the job that would otherwise require 300 microwave relay stations.

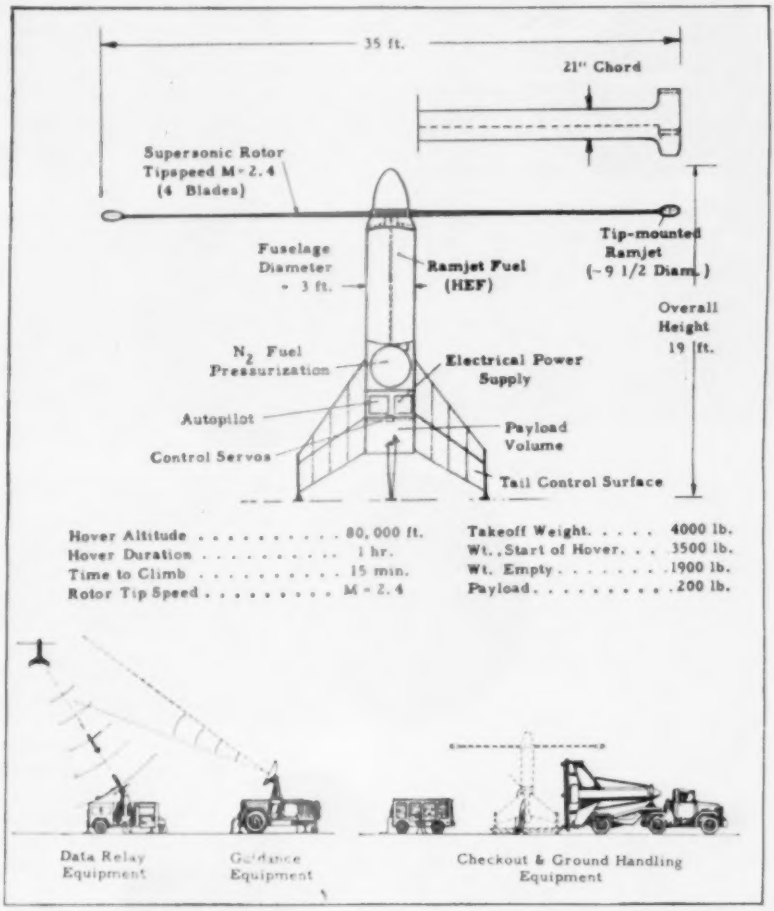
USI is still interested in pursuing this application for its platform but says it "hasn't had time to put anything down on paper yet." USI has also gone to Army Ordnance with the suggestion that its platform be used for target location and damage assessment in conjunction with or in place of the usual forward observer team set-up. USI plans to put details of the system together and make a formal presentation to Ordnance shortly.

Early-Warning Platform

More recently, USI has been in pursuit of a development contract for work on an early warning strato platform to be used in an anti-field ballistic missile system now under study by the Army Rocket Guided Missile Agency (AW Oct. 10, p. 27). This effort is part of ARGMA's nine-month in-house program that will parallel industry studies. Eventually, it is believed, ARGMA itself will do the final weapon system synthesis of the accepted detection, computation and kill subsystems and their components. USI's interest is in the development of a strato platform with suitable optical or infrared sensors that could be used as the early acquisition component of whatever anti-FBM system ARGMA finally decides upon.

Basically, the stratosphere rotor platform concept developed by the Military Systems Planning Group of U. S. Industries, Inc., divides into an airborne subsystem and a ground-based subsystem. The airborne subsystem consists of the airframe and payload. The airframe, powered by a large, four-bladed rotor with tip-mounted ramjets or rockets, flies with the fuselage essentially in a vertical position during climb, hover

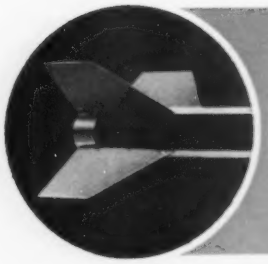
MODEL of stratosphere rotor platform under development by **U. S. Industries** is shown above. Vehicle would relay microwave signals from surveillance drones to ground stations.



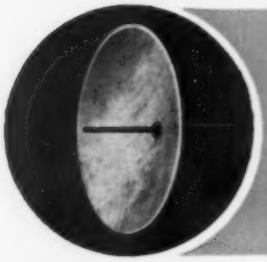
USI ENGINEERS say that an advanced stratosphere ramjet-powered rotor platform and associated ground support equipment such as that illustrated above could be ready for flight tests within 36 months.

CAN BONDING DO IT BETTER FOR YOU?

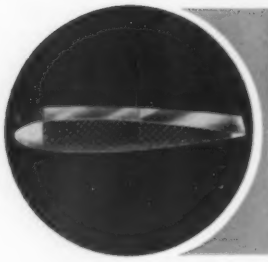
IN A RAPIDLY INCREASING NUMBER OF MANUFACTURING OPERATIONS, THE ANSWER IS YES... bonding can do a better job and can do it at less cost! Rohr is a pioneer in adhesive bonded metal techniques and structures and is projecting this unparalleled capability to the solution of many new manufacturing problems.



MISSILE AIRFRAMES AND BODY SECTIONS, such as this Rohr-built missile fin, can be made better and faster with bonded structures. Ideal strength/weight ratios, cleaner aerodynamic surfaces, better structural integrity for exposure to sonic vibration and long stand-by periods, lower tooling and production costs . . . just a few of the superior qualities of bonding.



RADAR REFLECTORS AND ANTENNAS are among the precision products made better by bonding. No other method provides such dimensional stability and accuracy, plus light weight and fine surface finish.



HELICOPTER BLADES, too, can be made from new bonding methods and materials developed by Rohr. The blade section illustrated is made with non-perforated honeycomb core . . . a technique which is also ideal for aircraft control surfaces.

These examples are but a few of the many ways that metal bonding is doing a better job. For more information about this, or other Rohr capabilities, write Mr. A. R. Campbell, Sales Manager, Department 3, Rohr Aircraft Corporation, Chula Vista, California

ROHR
AIRCRAFT CORPORATION

MAIN PLANT AND HEADQUARTERS: CHULA VISTA, CALIF.; PLANT: RIVERSIDE, CALIF.; ASSEMBLY PLANTS: WINDER, GA.; AUBURN, WASH.

and descent. Propellant, payload, guidance, stabilization and other equipment are carried inside the cylindrical fuselage. The cruciform tail surfaces, upon which the vehicle sits on the ground, provide the necessary aerodynamic control.

Payload, of course, will depend upon the vehicle's mission. In the case of the data relay platform, it will consist of a highly directional receiving antenna, receiver-transmitter equipment and an air-to-ground directional transmitting antenna. As a high-altitude surveillance platform, the vehicle would carry imaging or activity-detecting sensors such as telephoto cameras, radar and infrared scanners.

The ground-based subsystem, in the case of the data relay platform, includes command guidance equipment, checkout and ground handling equipment and equipment for receiving, processing, displaying and storing data relayed by the rotor platform.

Typical Configuration

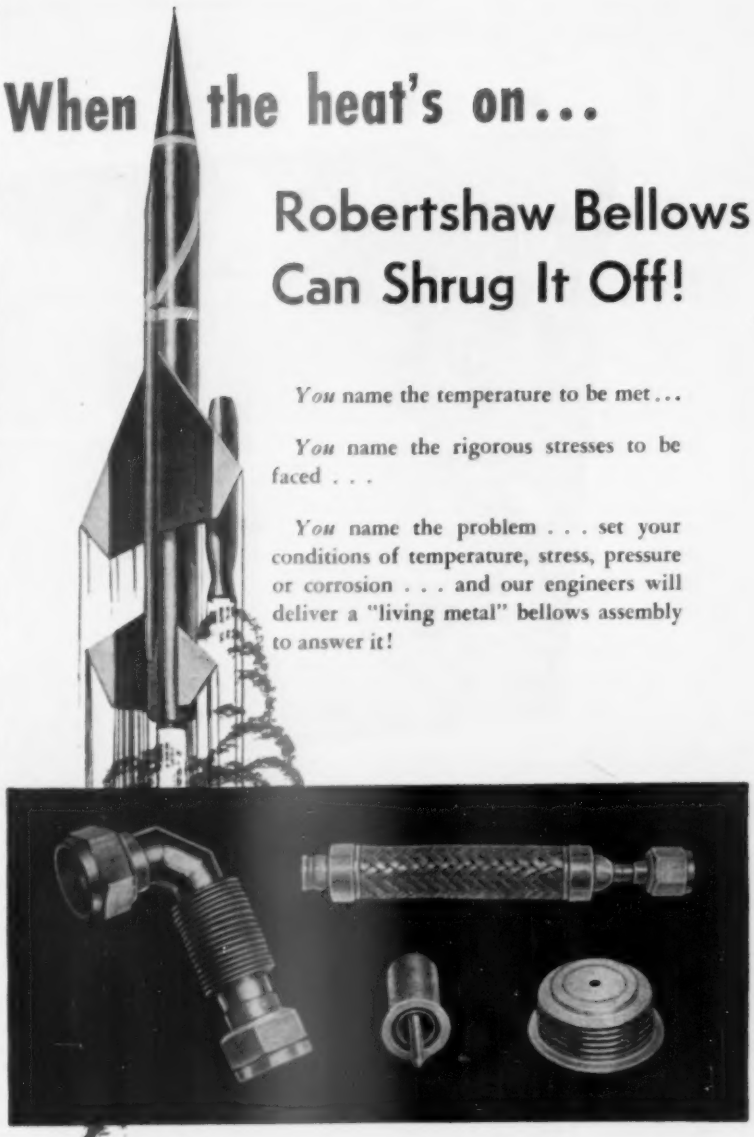
In a typical relay platform configuration, as currently envisioned by USI engineers, the vehicle would have an over-all height of 19 ft. and a body diameter, not counting fin span, of 3 ft. The platform would weigh 4,000 lb. at takeoff, 3,500 lb. at the start of hover and 1,900 lb. empty. Payload weight would be 200 lb.

Lift would come from a relatively highly-loaded, four-bladed rotor manufactured from new high-strength steel or titanium alloys. The rotor, including four 30-lb. ramjet engines, would weigh approximately 1,200 lb. Chord of each rotor blade would be 21 in. and over-all rotor diameter would be 35 ft. Rotor blades would be fixed to the hub. The whole assembly, blades and hub, would be able to tilt approximately 15 deg. Flat ramjet engines, 9½-in. in diameter and mounted on the rotor tips, would operate at approximately Mach 2.4 during cruise. Optimum angle of attack for supersonic airfoil sections of the rotor blade was calculated to be three to four degrees and for the subsonic sections, six to eight degrees. Blade lift-to-tip thrust ratio would be approximately 6.25.

To obtain maximum hover duration, says Thracy Petrides, director of USI's Government Programs Department, the vehicle will probably use a boron-based high-energy ramjet fuel. (For the platform configuration using small Reaction Motors rocket engines, the propellants would be MAF-1 (mixed amine fuels) and red fuming nitric acid.) Gaseous nitrogen will be used to pressure the propellant tank (or tanks in the case of the rocket version) sufficiently to raise the propellant to a plenum chamber metering unit mounted on the rotor hub. From here, the propellant will be

When the heat's on...

Robertshaw Bellows Can Shrug It Off!



You name the temperature to be met...

You name the rigorous stresses to be faced . . .

You name the problem . . . set your conditions of temperature, stress, pressure or corrosion . . . and our engineers will deliver a "living metal" bellows assembly to answer it!

Robertshaw Sylphon® Bellows, depending on properties desired, are available in brass, phosphor bronze, beryllium copper, monel, A-286 stainless steel, inconel, inconel-X and Ni-Span-C.

Robertshaw Bellows Assemblies may solve many of *your* problems . . . and we think you'll find a world of information in our Bellows Catalog TA-R. Why not write for it *today?*

Robertshaw

MR. CONTROLS

ROBERTSHAW-FULTON CONTROLS COMPANY

FULTON SYLPHON DIVISION • KNOXVILLE 1, TENNESSEE

Another MX Test System at work...

A. J. De Vries, Magnaflux Field Engineer, checks up the Magnaflux installation at the Chicago Screw Company Division of Standard Screw Company with Hugh J. Maplesden, Superintendent of Inspection. Unit tests wide variety of high quality bolts and similar parts used in heavy equipment, diesel engines, stamping dies, etc.

Low Cost Testing with Magnaflux— Accessories Adapt to Low or High Volume!

This testing installation is a "productionized standard" Magnaflux unit. The basic standard unit, Model TAQ-524, is fitted here with a bath applicating device, a short conveyor for proper positioning and orientation of the parts and an accessory sequencing control cabinet. Reliability and reproducibility of test results are assured and the test operation is an efficient integral part of the plant operation.

An auxiliary conveyor unit carries the parts from the TAQ to the inspectors and on through automatic demagnetization. Thus, high production rates are easily attained, when required. Varieties of shapes and sizes are readily processed.

This is a specific example of a broadly applied concept: "productionize" any of the standard Magnaflux units by employing standard or easily adaptable auxiliary components, all available from Magnaflux Corporation.

Phone or write our local Field Engineer, or write to Magnaflux Corporation, 7306 West Lawrence Avenue, Chicago 31, Illinois.

MAGNAFLUX CORPORATION

A SUBSIDIARY OF GENERAL MILLS

General Mills **TEST SYSTEMS**

MX Test Systems Include MAGNETIC PARTICLE, FLUORESCENT PENETRANT, THERMOGRAPHIC, EDDY CURRENT, ULTRASONIC, STRESS ANALYSIS, RADIOGRAPHIC TESTING, DYE PENETRANT & MAGNETIC FIELD

System	COSTS: Dollars/Hr. Relay Service (@ 10,000 hrs)	COSTS: Rank	EFFECTIVENESS: Jammability: Relative	Jammability: Rank	Security: Relative Area	Security: Rank	Quality: Rec. Power	Quality: Rank
1) Ground-Launched Balloon	$14,800	2	25	2	3.25	3	1.6	7
2) Rocket-Launched Balloon	$21,400	3	25	2	3.25	3	1.6	6
3) Rocket-Launched Parachute	$81,700	6	25	2	1	2	1.8	5
4) Station-Keeping Drone	$32,700	4	25	2	3.25	3	1.3	8
5) Penetrating Drone	$54,700	5	25	2	10	4	128	1
6) Rotor Platform	$7,980	1	1	1	0	1	96	2
7) Relay Satellites (2)	1 wk.	1 month						
a) Polar (200 mi)	$80,000	$18,800	2,500	3	5,000	5	3.2	4
b) Hovering (22,000 mi)	$37,000	$ 8,800	25,000	4	25,000	6	6.8	3

ANALYSIS performed by USI shows comparative costs and effectiveness ratings of seven different types of possible data relay vehicles.

carried by centrifugal force through fuel lines in the rotor blades to the tip-mounted engines.

In a typical mission, as presently planned, the USI strato platform would be carried in a horizontal position to the designated launching area on an 18-ft. tractor-trailer bed that would serve as a combined transporter-erector-launcher. The rotor blades would be folded back from the hub, down along the fuselage.

Ramjet-Powered Platform

For the ramjet version of the platform, ground power equipment or disposable solid rockets would be used to provide the necessary starting thrust. With ramjet power on, the vehicle will climb to its 80,000-ft. hover altitude in approximately 15 min.

Stability and control reportedly will be assured through use of an unconventional, skew-hinged rigid rotor design which is the subject of a patent application by Petrides and Wilfred Stapelfeld, project engineer on the program. This design will significantly reduce the destabilizing pitching moment experienced by conventional rigid rotors under cross-flow conditions, says Stapelfeld. It also eliminates the undesirable and extraneous maneuver response of a rigid rotor due to gyroscopic forces and instead uses these forces to move the blades so that the resulting aerodynamic forces rotate the plane of the rotor, thereby moving the vehicle in the desired direction.

Actual stabilization and aerodynamic control of the platform will be effected by movable tail surfaces situated in the rotor downwash or if necessary, says USI, by cyclical control of the lift of the rotor blades. The area, lift coefficient and moment arm at the tail surfaces, in conjunction with the dynamic pressure from the rotor downwash, Petrides adds, will be sufficient to counteract upsetting moments caused by crosswinds or other horizontal air velocities which may act on the rotor. Differential deflection of the tail surfaces will provide roll control or stabilization in azimuth.

Control signals will be transmitted to the vehicle's autopilot from the ground via command link. Lightweight ground radar, working in conjunction with a radar beacon in the platform, will be used to track the vehicle. For its relay work with surveillance drones, the platform will use an air-to-air relay antenna which will have an antenna pattern with a vertical field of view of approximately 90 deg. and a cosecant gain distribution.

A parachute housed in the rotor hub will probably be used, at least in early models, in the event of mechanical failure and, possibly, to ensure stability and save fuel during descent. Wherever possible, says USI, the platform will land with power on for accuracy and thereby assure a high retrieval probability.

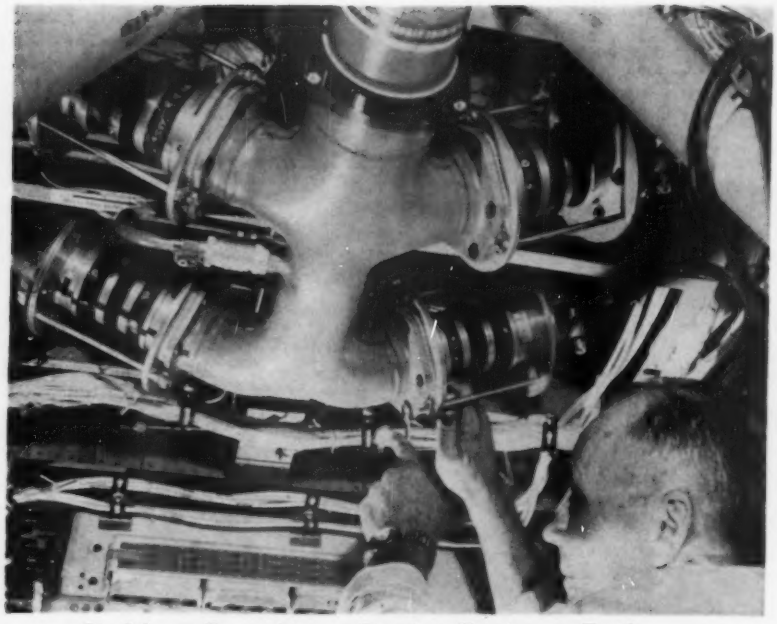
Three Approaches

Development of a final retrieval technique is one of the problems USI engineers still have to work out. Currently, their thinking is centered on three possible approaches: The first is autorotation combined with some final power and ground radar guidance. Power, probably from small solid propellant rockets, would be turned on just before impact and the platform would be guided in as a VTOL vehicle. The second approach is combined use of autorotation and a parachute with radar guidance. The third approach is simple parachute recovery.

The major attraction of the stratosphere rotor platform is its low cost-

Item \ System	Ground-Launched Balloon	Rocket Balloon	Rocket Parachute	Station-Keeping Drone	Penetrating Drone	USI Rotor Platform	Polar and Stationary Communication Satellites
Takeoff Wt. (lb.)	500	1,910	2,270	3,460	1,350	4,000	112,000 265,000
Operating Altitude (ft.)	100,000	100,000	230,000 to 80,000	80,000	20,000	80,000	2,000 22,000 mi.
"Hover" Device	115 ft. Balloon	100 ft. Balloon	120 ft. Parachute	60 ft. wing (exp)	25 ft. wing (tot.)	35 ft. dia. rotor	Gravity
Translation Speed	40 mph. wind drift	40 mph. wind drift	40 mph. wind drift	M = 2.5 Cruise	50 fps. Cruise	Stationary Hover	10,000 mph. 0
Climb time	2 hr.	80 sec.	120 sec.	100 sec.	———	15 min.	———
Useful Duration & Altitude	30 min. for 18% of units launched	1 hr.	15 min.	½ hr.	1 hr.	1 hr.	1 year
Powerplant	None	Solid Rocket	Solid Rocket	23-in. Ramjet	Turbojet	Tip Ramjets	ICBM Booster
Length (ft.)	125	22.5 (rocket)	19 (rocket)	21 (30 w/ booster)	18	21	95 at takeoff
Diameter	115 ft.	20 in. (rocket)	20 in. (rocket)	24 in.	18 in.	30 in.	10 ft. dia. core
Wing Span	———	———	———	12.5 ft.	8 ft.	35 ft. rotor	———

CHART prepared by USI engineers compares performance and physical characteristics of eight alternative data relay vehicles.



Rubber Couplings Resist Fatigue Failure

Lightweight rubber couplings protect fuel lifelines on Boeing B-52G bomber and KC-135 tanker. The new couplings, made by B. F. Goodrich Co., Akron, Ohio, withstand torsional loads that cause fatigue failure in metal couplings.

effectiveness, according to Stapelfeld. For data relay, surveillance and detection, target location, meteorological and navigation missions, he says, the strato platform can do the most effective job at the lowest cost. In an early phase of this project, USI engineers carried out a detailed cost and effectiveness analysis of eight different vehicles—ground-launched balloon, rocket-launched balloon, rocket-launched parachute, station-keeping drone, penetrating drone, rotor platform, 200-mi. polar satellite and a 22,000-mi. hovering satellite—that might be used as a high-altitude relay station in conjunction with surveillance drones for battlefield operations. The stated mission was for the relay station to receive surveillance data, transmitted at microwave frequencies, from a surveillance drone flying at low altitudes out to ranges of 400 mi. and then to transmit this data to a ground station where it will be processed and displayed.

Cost Analysis

The results of this USI analysis showed that the rotor platform would have the lowest operational cost at $7,900 per hour of relay service figured on a 10,000-hour basis. The analysis also showed that the rotor platform ranked first in effectiveness in regard to jammability and security, and second (to the penetrating drone) in quality of signal strength.

Military men who have examined USI's work to date generally agree with company's cost comparison results. At the same time, however, many of them point out what they consider serious problems that must be solved before the stratosphere platform proves feasible. Among other things questioned by the military are the following:

• **Stability and control** of the vehicle at 60,000 ft. They feel that the vehicle would require more than the 55 lb. of control equipment allotted by USI. They believe that the fuselage would rotate and that the vehicle would tend to precess. They also pointed out that the effects of airflow over the tail control surfaces were not yet adequately determined.

• **Structural and aerodynamic** characteristics of the strato platform at 100,000 ft. Even if it is assumed that all the problems of the vehicle at 60,000 ft. can be solved, they say, there is no guarantee that these problems would stay solved at 100,000 ft. One factor in particular that worries them is the high loading of the rotor hub which at speeds above Mach 2 would exceed 10,000g.

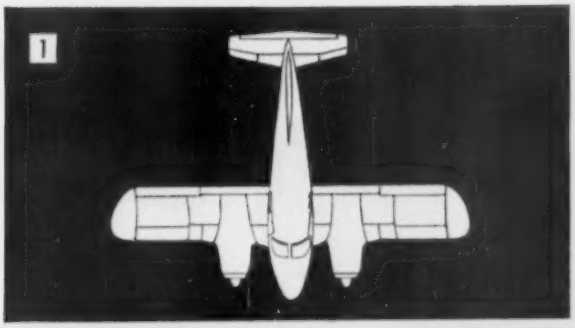
• **Electronic interference.** Effects of rotor modulation, they believe, may create interference problems in the operation of the electronic equipment carried by the platform.

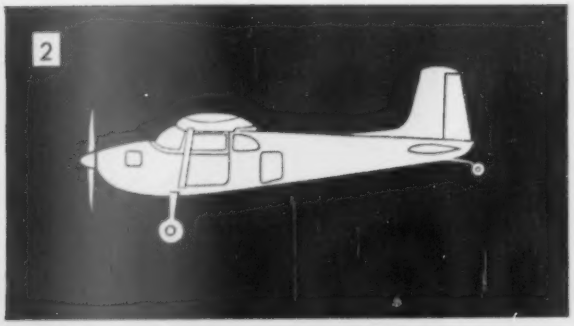
Problem Possibilities

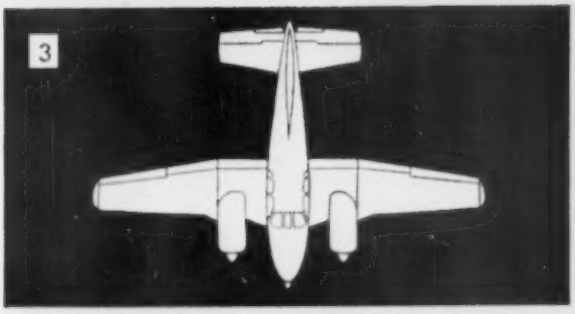
In reply, USI's Petrides says that all the problem possibilities raised to date have been or will be solved. The lightweight autopilots now available, he says, make the 55-lb. estimate for control equipment realistic. The precession problem is answered by the adoption of a hinged rotor arrangement. If necessary, roll control jets will be used to prevent the fuselage from turning in the same direction as the rotor as a result of friction. Use of the newer high strength-high temperature steels such as Udimet 500 and titanium alloys in the rotor assembly will meet any high-loading or high-temperature problems likely to be encountered. Antenna design will

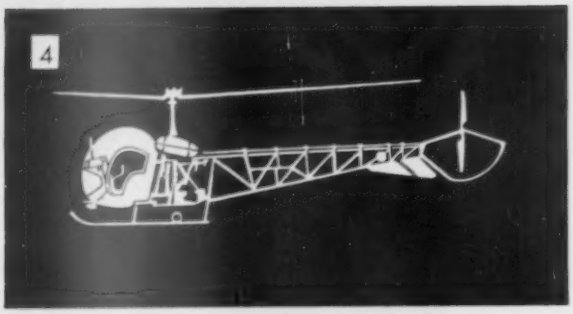
Close Tolerances for Jet Parts

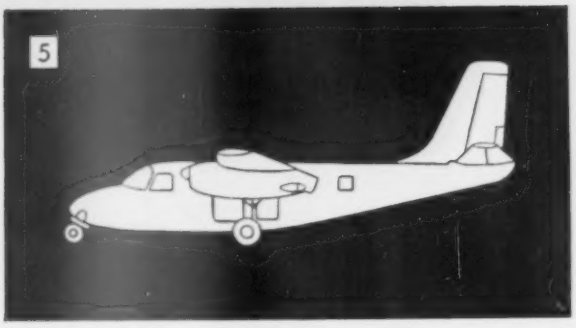
Reinforcing band for jet engine is formed from alloy made by Haynes Satellite Co. Tough alloy jet parts can be held to tolerances within 0.003-0.005 in. in this hydroforming device.





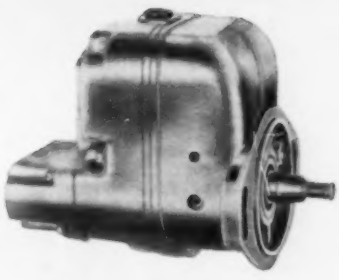






Although differing in appearance,
they all have one thing in common . . .

NEW BENDIX S-200 MAGNETOS



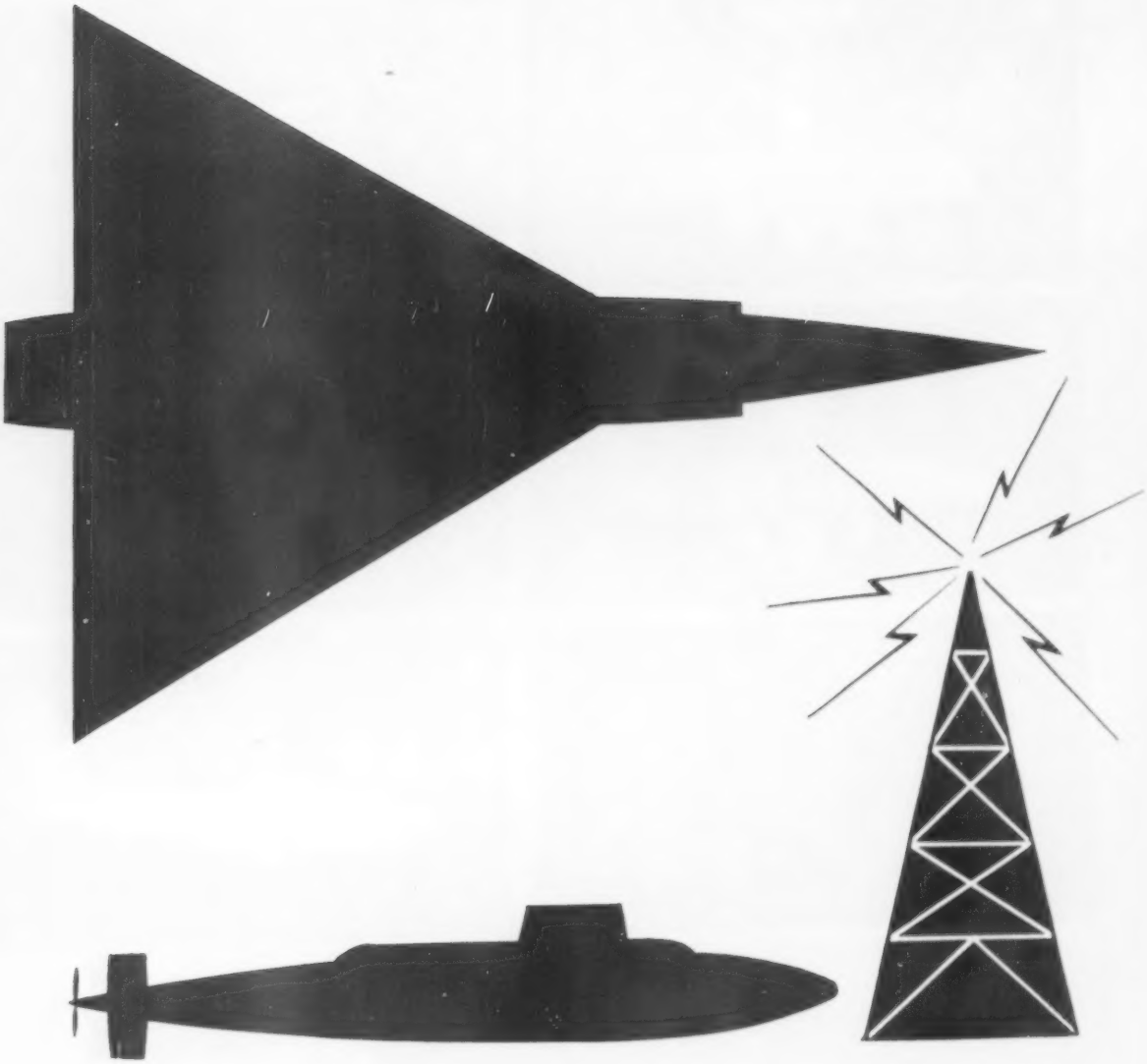
Here's a completely new, widely acclaimed ignition unit that provides superior performance and improved starting so necessary for today's 4- and 6-cylinder business aircraft.

In the Bendix® S-200 magneto, a great new design concept eliminates the mechanical impulse coupling. Replacing it, a retard breaker and battery-operated vibrator produce a "shower of sparks" at the spark plug through high voltage induction in the magneto's secondary. A combination ignition-starting switch automatically controls starting and operation of retard breaker, magneto and booster. The S-200 magneto is typical of Bendix capabilities in delivering superior ignition equipment, including magneto systems for aircraft of all types and sizes. Write today for complete information on the S-200 magneto or other ignition needs.

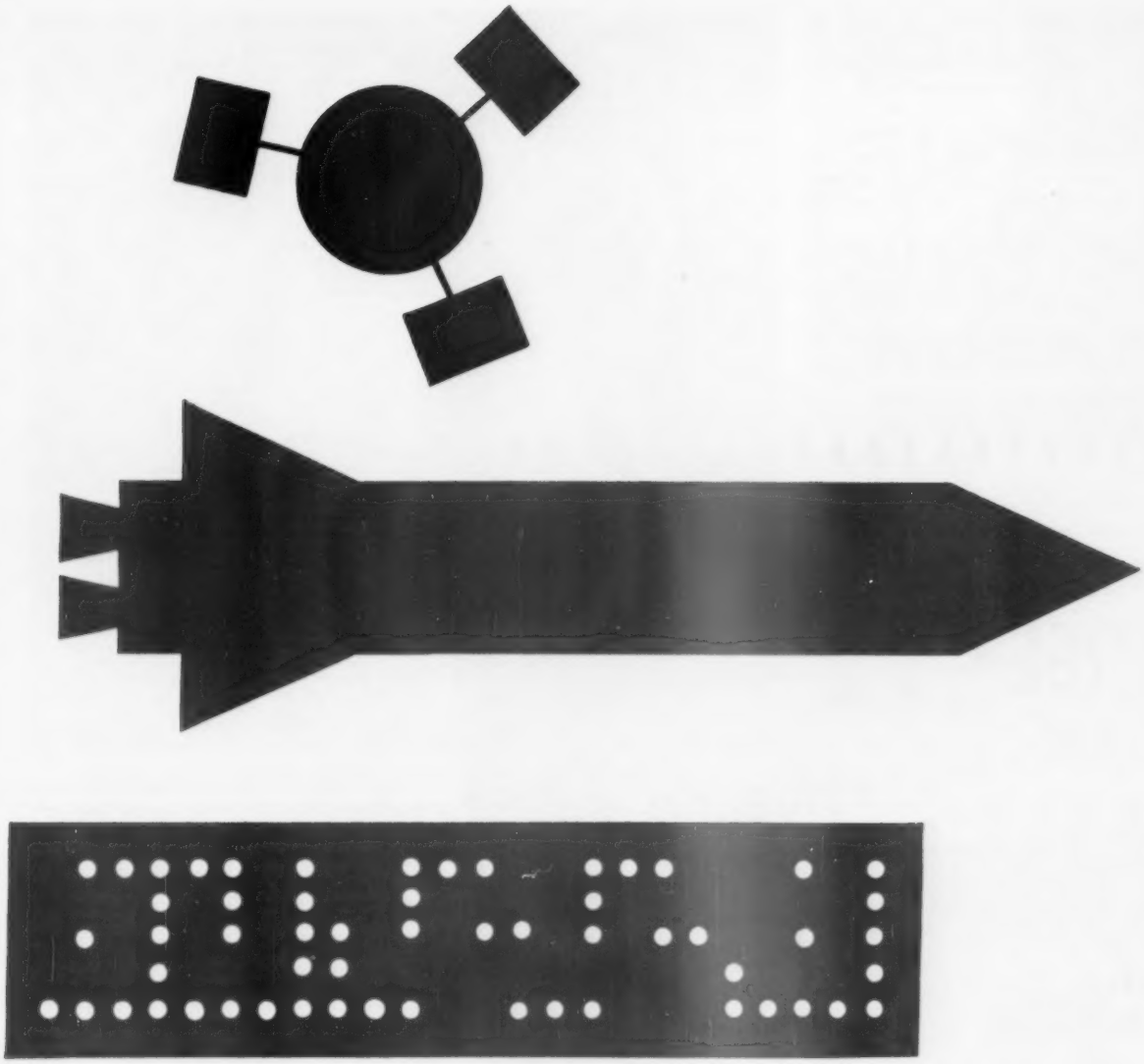
Pictured above: 1. Piper Aztec 2. Cessna 180 3. Beechcraft Twin Bonanza 4. Bell 47-G2 Helicopter 5. Aero Design—Model 500

Scintilla Division
SIDNEY, NEW YORK

THE Bendix CORPORATION



CANNON PLUGS . . . WORLD



STANDARD FOR RELIABILITY

For almost half a century Cannon products have been accepted as the highest standard of performance in the industry. From the first plug design for "talking pictures" to the latest highly specialized equipment for space-age projects, our prime objective has been to meet or exceed the ever changing needs of our customers. We are dedicated to maintaining the reputation that has made Cannon Plugs synonymous with quality and reliability. For information on Cannon Plugs—for any application —write to:

CANNON PLUGS

CANNON ELECTRIC COMPANY, 3208 Humboldt Street, Los Angeles 31, California

minimize reflection from the rotor, he continues; and the proper use of frequency modulation in the transmission link will eliminate any effects from rotor modulation.

Answers to many of the other questions such as the effects of airflow over tail control surfaces will have to wait for the scale model test program USI hopes to get under way shortly at its Westchester County (N.Y.) Airport facility. But Thracy Petrides and the other USI engineers are confident that the answers will come and that there are no insoluble problems inherent in their stratosphere rotor platform concept.

NASA Contracts

The National Aeronautics and Space Administration awarded the following contracts, totaling more than $134 million, during the period Jan. 1, 1960, through June 30, 1960. The figures shown represent the estimated total cost of the contract.

LANGLEY RESEARCH CENTER, Hampton, Va.

Aerolab Development Company Pasadena, Calif.—$80,000—Services and materials for manufacturing, test and delivery of three sets of booster hardware for 3 TX-33 rocket motors.

Northern Radio Company, Inc. New York, N. Y.—$99,925—Services and materials for transmission system.

Hermes Electronics Co. Cambridge, Mass. —$303,821—Services and materials for range programing and timing system.

Horne Brothers, Inc. Newport News, Va. —$44,800—Services and materials for new turning vanes and wind screen for transonic tunnel.

Aldrich Pump Co. Allentown, Pa.—$63,248—Services and materials for high pressure water pump.

Grenco Services, Inc. Langley Air Force Base, Va.—$28,700—Services and materials for furnishing and installing air piping in noise research laboratory.

Consolidated Electro-Dynamics Corp. Washington, D. C.—$42,000—Recorder amplifier and systems.

Berkley Division, Beckman Instruments Richmond, Calif.—$39,564—Analog computing equipment.

Boonshaft and Fuchs, Inc. Hatboro, Pa. —$25,630—Furnish one two-channel dynamic loading control system.

Radio Corporation of America, Communications, Inc. New York—$181,650—Project Mercury communications.

Consolidated Electrodynamics Corp. Monrovia, Calif.—$90,000—Galvanometers.

Simmonds Precision Products, Inc. Tarrytown, N. Y.—$149,921—Antennas and receivers.

Chesapeake and Potomac Telephone Co. of Virginia Richmond, Va.—$281,200—Furnish and install a direct varied pressurized multiconductor cable for a distance of nine miles between Chincoteague and Wallops Island, Va.

R. C. A. Service Co., Division of R. C. A. Camden—$36,000—Radar maintenance.

Doyle and Russell Norfolk, Va.—$212,430 —Extending manhole and ductbank.

Dage Television, Thompson Ramo Wooldridge, Inc. Michigan City, Ind.—$185,886—Closed circuit television system.

Data-Control Systems, Inc. Danbury, Conn.—$30,720—Three switchable and nine subcarrier discriminators.

Elwood H. Bull Parksley, Va.—$70,000—Janitorial services for Wallops Station, Chincoteague, Va. and Wallops Island, Virginia for FY 1961.

William J. Gillespie Chincoteague, Va.—$62,729—Ground maintenance.

Electronic Associates Long Branch, N. J. —$1,510,000—Analog computing equipment.

Alco Products, Inc. Dunkirk, N. Y.—$72,100—Air heater and spare parts.

Boonshaft and Fuchs, Inc. Hatboro, Penna.—$87,430—Design, test and furnish a direct fired air heater.

Norton Co. Worcester, Mass.—$30,864—Replacement refractory lining and pebble bed for repair of 71-in. ceramic heated jet facility.

Bendix Corp., Cincinnati Division Cincinnati, Ohio—$43,859—Console, time of flight mass spectrometer analyzer and vacuum system.

Hogue Electric Manufacturing Co. Paterson, N. J.—$35,549—Services and materials for one 45 kva. power supply.

E. C. Ernst, Inc. Washington, D. C.—$44,546—Power supply for hypersonic jet heater.

Radiation Dynamics, Inc. Westbury, Long Island, N. Y. —$86,850 — Communications systems for satellite applications.

F. A. Bartlett Tree Expert Co. Richmond Va.—$48,674—Maintenance of lawns.

General Chemical Div., Allied Chemical Corp. New York, N. Y.—$44,960—Gas for refrigeration as required.

E. I. DuPont deNemours & Co. Wilmington, Del.—$51,400—Gas for refrigeration as required.

Doyle and Russell Norfolk, Va.—$124,480 —Services and materials for liquid fuel storage at Wallops Island.

Leon H. Perlin Co., Inc. Newport News, Va.—$131,800—Services and materials for modifications of existing gust tunnel.

Doyle and Russell Norfolk, Va.—$106,926 —Services and materials for auxiliary launching pad at Wallops Station.

E. C. Ernst, Inc. Denbigh, Va.—$25,717—Services and materials for equipment power supply to an arc jet.

American Potash and Chemical Corp. Los Angeles, Calif.—$41,964—Ammonium perchlorate, a propellant ingredient for solid rocket motors.

Alco Products, Inc. Atlanta, Ga.—$28,000

it's FREE- just ASK!

the NEW Buckeye aviation refueling equipment catalog

Contains Facts and Figures on Buckeye's complete line of new aviation refueling equipment.

- OVERWING REFUELING NOZZLES
- UNDERWING REFUELING NOZZLES
- OIL NOZZLES
- VALVES AND ADAPTERS
- HYDRANT COUPLING AND EMERGENCY VALVES
- HYDRANT ADAPTERS
- HYDRANT MANHOLES
- MILITARY SPECIFICATION REFUELING EQUIPMENT

If you have anything to do with the purchase or specification of aviation refueling equipment, or if you're just curious, we want you to have a copy of our new Buckeye Aviation Refueling Equipment catalog. It's free for the asking.

Write BUCKEYE IRON & BRASS WORKS
Aviation Department
PO Box 883, Dayton 1, Ohio
Please send free Aviation Refueling Equipment Catalog AW-660
NAME
ADDRESS
CITY STATE

Minuteman Nose Cone Reveals Antennae

Flight test dummy of the Avco Mk.5 nose cone for the USAF Minuteman ICBM reveals two antennae windows—the smaller presumably for telemetry and the larger for tracking purposes. The Minuteman ablating vehicle is made of Avcoite, a plastic compound capable of withstanding extremely high temperatures with very little material and weight loss. The vehicle has been designed for much higher re-entry speeds than Atlas or Titan nose cones.

—Services and materials for high pressure water heat exchanger.

Georgia Tech Research Institute of Technology Atlanta, Ga.—$38,292—Preparation of mathematical procedure for determining the drag forces acting on an artificial satellite.

Fred S. Gichner Iron Works, Inc. Beltsville, Md.—$58,400—Modify six (6) government owned semi-trailers for Project Mercury.

Mobile Aerial Towers, Inc. Ft. Wayne, Ind.—$62,717—Services and materials to design, fabricate and equip one pilot's capsule access tower for Project Mercury.

WESTERN OPERATIONS OFFICE, Santa Monica, Calif.

Douglas Aircraft Company, Inc. Santa Monica, Calif.—$68,838,160—Services and material to provide for the design, development, fabrication and test of 10 Saturn S-IV stage vehicles.

AMES RESEARCH CENTER, Mountain View, Calif.

Beckman and Whitley, Inc. San Carlos, Calif.—$91,745—High-speed motion picture camera for high-speed impact studies in the hypervelocity ballistic range.

Norton Company Worcester, Mass. —$371,340—Zirconia and magnesia pebbles for pebble air heater for 3 x 5-ft. wind tunnel (hypersonic).

Vidya, Inc. Palo Alto, Calif—$63,103—Development, construction and delivery of a density measuring instrument for heat transfer arc heated wind tunnel.

A. O. Smith Corporation San Francisco, Calif.—$39,896—Pressure vessel for mass transfer cooling and aerodynamic facility.

Fischer Research Laboratory, Inc. Palo Alto, Calif.—$48,000—Indicating millivolt potentiometers for general use in tunnel tests.

Precision Instrument Co. San Carlos, Calif. — $26,820 — Recorder-reproducer, 14 channel for tests in the 12-ft. tunnel.

Litton Industries of California San Carlos, Calif.—$35,320—Area light source for photography of 20,000 ft./sec.

Task Corporation Anaheim, Calif.—$27,230—Internal strain gage balance for use with low-lift type vehicles in the 8 x 7 ft. supersonic wind tunnel.

Norwalk Company, Inc. South Norwalk, Conn.—$32,765—Air compressors for mass transfer cooling and aerodynamic facility.

Applied Radiation Corporation Walnut Creek, Calif.—$170,335—Ion accelerator for extension of energy range of existing accelerator.

General Electric Co., Technical Products Operations Electronics Park, Syracuse, N. Y.—$30,590—Television system for sighting and control test for orbital astronomical observatory.

Simpson and Stratta San Francisco, Calif.—$70,525—Architect and/or engineer services for Data Reduction Center Bldg.

Ryan Aeronautical Co. San Diego, Calif. —$150,402—Rebuilding of VZ-3RY "Vertiplane" which crashed.

Electronic Associates, Inc. Long Branch, N. J.—$353,625—Analog computer system.

Southwestern Engineering Co. Los Angeles, Calif.—$806,500—Vacuum system for mass transfer cooling and aerodynamics facility.

Linde Co. San Francisco, Calif.—$70,270 —Liquid oxygen storage and dispensing facility.

FLIGHT RESEARCH CENTER, Edwards, Calif.

Aetna Maintenance Co. Los Angeles, Calif.—$26,000—Janitorial services.

THE STANDARD OF CALIBRATION

RUSKA DEAD WEIGHT GAGE

A sensitive dead weight pressure balance for use as a primary pressure standard. Repeatability in excess of 0.01%. Ranges up to 12,000 psi, with subdivisions as small as 0.1 psi.

Write for complete literature.

RUSKA INSTRUMENT CORPORATION
MAKERS OF SCIENTIFIC INSTRUMENTS
6121 Hillcroft Street, Houston, Texas
Mail Address: P. O. Box 3396, Bellaire 101, Texas

WHEN QUALITY IS YOUR TARGET
THE GRIPWELL ELECTRONIC CHASSIS
LATCH HELPS YOU HIT THE BULLSEYE

Red unlock indicator
Secondary extreme vibration lock
Proven Hartwell trigger action lock
Permanent Gripwell handle
20° free travel for gripping
Keeper designed for easy sealing
Boss for optional bar handle

½" take-up • 8 to 1 mechanical advantage

GRIPWELL® ELECTRONIC CHASSIS LATCH

A handsome, strong and durable handle latch to fasten "plug-in" type electronic chassis, providing for positive ejection and injection of the chassis and allowing an eight to one mechanical advantage, with a total one-half inch take up.

Write today for complete information

THE HARTWELL CORPORATION
9035 VENICE BOULEVARD, LOS ANGELES 34, CALIF.
Offices:
Chicago • Ft. Worth • Hackensack • Seattle • Wichita

THE PROBLEM SOLVERS

AEROLAB — WORLD LEADER IN SPACE PROBES

Nose cones of hard-to-form Inconel, designed and built by Aerolab for the ARGO D-4 (Javelin) sounding rocket, undergo final inspection. Equipped with Inconel spike antenna, these four stage rockets will be used by NASA for the low-cost acquisition of important data at high altitudes and velocities.

Aerolab has developed more space probes and rocket-powered research models, including the Mercury capsule model, which have been fired, than any other firm in the United States.

Aerolab is a science team with quick reaction capabilities . . . a group of scientists and engineers with special talents for solving advanced problems in astrophysics, aerophysics and geophysics.

A wholly-owned subsidiary of Ryan Aeronautical Company, Aerolab now adds its capabilities to Ryan's own in accomplishing breakthroughs in such vital areas of space technology as: electronic navigation, automatic guidance, recovery systems, missile design, reaction controls, propulsion systems, solid state devices, and instrumentation packages.

RYAN OFFERS CHALLENGING OPPORTUNITIES TO ENGINEERS

RYAN AEROLAB

DEVELOPMENT COMPANY ■ PASADENA, CALIFORNIA

SUBSIDIARY OF RYAN AERONAUTICAL COMPANY ■ SAN DIEGO, CALIFORNIA

Space Vehicle Log

Satellites in Orbit	Name	Source	Launch	Period Mins.	Apogee Stat. Mi.	Perigee	(Transmission Freq. (mc.)	Est. Lifetime
1958 Alpha	Explorer I	US	1 Feb. 58	107.7	1185	217	108-108.03	3-5 yrs.
1958 Beta I	Rocket Body	US	17 Mar. 58	138.4	2693	402		
1958 Beta II	Vanguard I	US	17 Mar. 58	133.8	2449	403	108-108.03[1]	200-1,000 yrs.
1959 Alpha I	Vanguard II	US	17 Feb. 59	125.5	2051	349	108-108.03	10 yrs.
1959 Alpha II	Rocket Body	US	17 Feb. 59	129.6	2276	347		
1959 Delta	Explorer VI	US	7 Aug. 59	Position Uncertain (Highly Elliptical)			108.06-108.09[2]	Over 1 yr.
1959 Epsilon II	Capsule	US	13 Aug. 59	97.8	691	120		
1959 Eta	Vanguard III	US	18 Sept. 59	129.8	2316	320	108-108.03	30-40 yrs.
1959 Iota I	Explorer VII	US	13 Oct. 59	101.2	672	344	108-20-40-60[3]	20-30 yrs.
1959 Iota II	Rocket Body	US	13 Oct. 59	101.1	666	343		
1960 Beta I	Rocket Body	US	1 Apr. 60	99.1	466	429		
1960 Beta II	Tiros I	US	1 Apr. 60	99.2	468	429	108-108.03-235 (video)[1]	50-100 yrs.
1960 Gamma I	Rocket Body	US	13 Apr. 60	94.0	411	179		
1960 Gamma II	Transit 1B	US	13 Apr. 60	95.4	438	238	54-162-216-324	16 mo.
1960 Gama III	Metal Object	US	13 Apr. 60	93.5	383	177		
1960 Epsilon I	Sputnik IV	USSR	15 May 60	93.8	395	175	19.995	Uncertain
1960 Epsilon III	Metal Object	USSR	15 May 60	94.0	411	172		
1960 Epsilon IV	Metal Object	USSR	15 May 60	93.7	391	176		
1960 Epsilon V	Metal Object	USSR	15 May 60	Position Uncertain				
1960 Epsilon VI	Metal Object	USSR	15 May 60	Position Uncertain				
1960 Epsilon VIII	Metal Object	USSR	15 May 60	90.1	174	174		
1960 Epsilon IX	Metal Object	USSR	15 May 60	89.4	151	151		
1960 Zeta I	Midas II	US	24 May 60	94.4	317	300	[1]	40 mo.
1960 Zeta II	Metal Object	US	24 May 60	93.3	277	277		
1960 Eta I	Transit IIA	US	22 June 60	101.7	650	389	54-162-216-324[1]	50 yrs.
1960 Eta II	Grab	US	22 June 60	101.7	658	381	108[1]	50 yrs.
1960 Eta III	Rocket Body	US	22 June 60	101.4	639	383		
1960 Theta	Discoverer XIII	US	10 Aug. 60	92.5	335	153		Uncertain
1960 Iota I	Echo I	US	12 Aug. 60	118.0	1118	866	108.06-107.94[1]	1 yr.
1960 Iota II	Rocket Body	US	12 Aug. 60	118.0	1031	950		
1960 Iota III	Metal Object	US	12 Aug. 60	115.6	924	923		
1960 Iota IV	Metal Object	US	12 Aug. 60	116.0	934	934		
1960 Iota V	Metal Object	US	12 Aug. 60	119.1	1100	945		
1960 Mu	Discoverer XV	US	13 Sept. 60	92.7	380	125		

Lunar and Space Probes		Source	Launch	Status	
Pioneer IV		US	3 Mar. 59	Orbiting Sun	960.05
Lunik I	(Mechta)	USSR	2 Jan. 59	Orbiting Sun	19.997-19.995-19.993-183.6
Lunik II		USSR	12 Sept. 59	Hit Moon—13 Sept. 59	183.6-39.986-19.993-19.997-20.003
Pioneer V	(60 Alpha)	US	11 Mar. 60	Orbiting Sun	378-150 watts

Decayed Satellites		Source	Launch	Dawn	
1957 Alpha I	Rocket Body	USSR	4 Oct. 57	1 Dec. 57	
1957 Alpha II	Sputnik I	USSR	4 Oct. 57	Early Jan. 58	20.005-40.002
1957 Beta	Sputnik II	USSR	3 Nov. 57	14 Apr. 58	20.005-40.002
1958 Gamma	Explorer III	US	26 Mar. 58	28 June 58	108-108.03
1958 Delta I	Rocket Body	USSR	15 May 58	3 Dec. 58	
1958 Delta II	Sputnik III	USSR	15 May 58	6 Apr. 60	20.005-40.01
1958 Epsilon	Explorer IV	US	26 July 58	23 Oct. 59	108-108.03
1958 Zeta	Atlas	US	18 Dec. 58	21 Jan. 59	132.435-132.905-107.97-107.94
1959 Beta	Discoverer I	US	28 Feb. 59	Early Mar. 59	
1959 Gamma	Discoverer II	US	13 Apr. 59	26 Apr. 59	
1959 Epsilon I	Discoverer V	US	13 Aug. 59	28 Sept. 59	
1959 Zeta	Discoverer VI	US	19 Aug. 59	20 Oct. 59	
1959 Theta	Lunik III	USSR	4 Oct. 59	About 20 Apr. 60	183.6-39.986
1959 Kappa	Discoverer VII	US	7 Nov. 59	26 Nov. 59	
1959 Lambda	Discoverer VIII	US	20 Nov. 59	8 Mar. 60	
1960 Delta	Discoverer XI	US	15 Apr. 60	26 Apr. 60	
1960 Epsilon II	Rocket Body	USSR	15 May 60	17 July 60	
1960 Lambda I	Sputnik V	USSR	19 Aug. 60	20 Aug. 60	19.995
1960 Kappa	Discoverer XIV	US	18 Aug. 60	15 Sept. 60	
1960 Lambda II	Rocket Body	USSR	19 Aug. 60	23 Sept. 60	
1960 Epsilon VII	Metal Object	USSR	15 May 60	24 Sept. 60	

Notes: (1)—still transmitting—no video transmissions from Tiros I; (2) included UHF transmitter; (3) timer included in package to turn off 108 mc. transmitter Oct. 13, 1960.

Where transmitting frequencies are not given, they have been classified.

Estimated lifetimes of objects trailing main satellites are approximately the same as the scientific packages.

Source: National Space Surveillance Control Center and National Aeronautics and Space Administration.

a new look on the horizon...

FLYING PLATFORMS FROM DEL MAR

Now, from Del Mar, a new weapons support concept provides three-dimensional mobility for our land and sea forces. Tiny helicopters, available in one-man or drone versions, give manned-flight and cargo-carrying capability to front-line Army and Marine units.

Weighing approximately 300 pounds empty, these miniature flying packages can safely scout hostile territory... send back reconnaissance data... carry a man or critical cargo to strategic hard-to-reach areas... perform courier services and ASW duty at sea.

The new flying platforms are the latest in a line of advanced weapons support systems from Del Mar. For further information on these or other Del Mar weapons support and training systems in use by the Armed Forces of the United States, Canada, and other NATO nations, write to Dept. AW-932-5.

Engineers and Scientists: investigate Del Mar for a rewarding future in hydrospace sciences, aerospace sciences, and environmental systems.

Del Mar ENGINEERING LABORATORIES

International Airport · Los Angeles 45, Calif.

Navy Designs Caleb For Space Missions

China Lake, Calif.—Four stage, air-launched solid propellant rocket called Caleb has been designed, built and tested by the Naval Ordnance Test Station for space missions including the launch of small satellites weighing between 10 lb. and 20 lb.

Caleb has had little or no formal funding but has been continued as a project by NOTS scientists. Close observers are hopeful that successful tests over Pacific Missile Range will win the project more conventional support and possibly result in some contracts for industry. So far, all the work has been done at Naval Ordnance Test Station.

Caleb is launched from the bomb rack of a fighter plane at 38,000 ft. in a standard loft bombing delivery. Conventional low altitude bombing system (LABS) used by Navy for loft bombing is said to be accurate enough to enable the spin-stabilized Caleb rocket to put its payloads in fairly precise orbits.

Caleb also may be used for projecting probes horizontally or vertically for high altitude studies. It may be used in booster configurations with one, two, three, or four stages of propulsion. To orbit a satellite, the launch would be made at an elevation angle of 56 deg. A high altitude probe version would be launched at an elevation of some 85 deg.

Caleb is 16.5 ft. long, 2 ft. in diameter and weighs 3,000 lb. at launch. It has been fired from under the wing of a Douglas F4D in tests over the Pacific Missile Range and there are plans to launch it from the much faster McDonnell F4H.

Satellite Antennas To Be Made in Orbit

Washington—The Canadian topside sounder satellite, now under construction at de Havilland Aircraft of Canada, Ltd., will use a novel space extrusion process to form its four long payload antennas.

Two 67-ft. and two 35-ft. antennas will be carried in the launch package, like a rolled steel tape measure. Once the satellite is in orbit, a small motor will force the flat metal through a circular guide, causing the edges to curl together forming a cylinder and activating the system.

Sweep frequency topside sounder (AW Aug. 29, p. 92) will be launched by the Thor Agena B space vehicle from the Pacific Missile Range in a polar orbit.

Cessna Skyhook helicopter, new entry in the commercial market, will cost $79,960 in four-place configuration.

Cessna Enters Skyhook Helicopter in Civil Market

Cessna Aircraft Co. has set up a world-wide marketing organization for sales of its newest commercial entry, the Skyhook helicopter, civil version of the Army CH-1C. Although it has been certificated for instrument weather operations, Cessna said Skyhook initially will be offered only in the VFR version. Aircraft has a maximum gross weight of 3,100 lb. and an empty weight of 2,080 lb. Powerplant is a forward-mounted Continental FSO-526A supercharged engine rated at 270 hp. Skyhook is certificated for cruising speeds up to 122 mph. Full 400 rpm. range is available at all altitudes, according to Cessna engineers. Rate of climb at gross weight is 1,030 fpm. at 8,000 ft. Fuel capacity is 60 gal., with auxiliary tanks holding 30 additional gallons also available. Cessna now has the Skyhook in initial production phases and first deliveries are expected to be made in 1961.

Skyhook helicopter is fitted with dual controls. Instrumentation includes the company's patented maximum airspeed indicator; by adjusting indicator for gross weight at a particular altitude, red line automatically indicates maximum speed. Interior is at right.

Jets Swelling U.S. Aeronautical Exports

By Katherine Johnsen

Washington—U. S. aeronautical exports, swelled by jet transport deliveries, are expected to reach a peak of over $1.4 billion this year, then start a downward trend to $1 billion in 1961, according to estimates of Commerce Department and Aerospace Industries Assn.

The 1960 total—the biggest since World War II—includes approximately $500 million in turbine-powered transports. This is expected to drop to about $300 million next year. The 1959 export total was $779 million, including approximately $103 million in turbine-powered aircraft.

At a major government-industry conference, sponsored by the Commerce Department, industry spokesmen urged government cooperation in two main areas to counter the prospective export decline: negotiation of lower foreign tariffs on U. S. imports, particularly on small aircraft, and more liberal Export-Import Bank financing arrangements for foreign purchasers.

Irving H. Taylor, AIA's export director, told the conference that "the Russian attack has already begun" on the international aviation front. "U. S. industry, singlehanded, will have no possible chance of coping with this competition—'giveaway samples,' long-term (possibly up to 20 years at 2% deferred interest and unlimited), free 'technical assistance' to customers—and they will eventually be offering products which will probably be by no means inferior to ours. The U. S. government will have to be prepared to support our industry in a big way or accept inevitable defeat in this area having important prestige and national defense aspects."

Soviet Sales

Commerce Department spokesmen noted the Soviet tactic of economic penetration through air transportation—aircraft sales followed by technical advisory crews—as a forerunner to political penetration. The recent Russian inroad into African transportation with the sale of four Ilyushin Il-18 aircraft to Ghana and the sale of four Ilyushin Il-14s by Czechoslovakia to Guinea for national airlines were cited as examples.

Major factor in Ghana's purchase of Russian instead of U. S. aircraft is understood to be the more favorable financing terms, with a 20 year period for liquidation allowed, compared with the seven year period required by Export Import Bank.

Commerce Department figures show the dominant position of U. S. aircraft in world commercial aviation. Of a total of 7,164 aircraft of 20,000 lb. or over in commercial use, 4,222 or approximately 60% are U. S.-built and 1,947, approximately 27%, are Soviet-built. The Soviet figure was furnished by Aeroflot. Commerce estimates that of approximately 600 commercial aircraft on order throughout the world, over 75% are U. S.-built and only 2% Soviet-built.

Urging Commerce Department "to exert all possible influence in establishing more liberal, flexible, financing facilities," Erle H. Constable, assistant treasurer of Lockheed Aircraft Corp., told the conference:

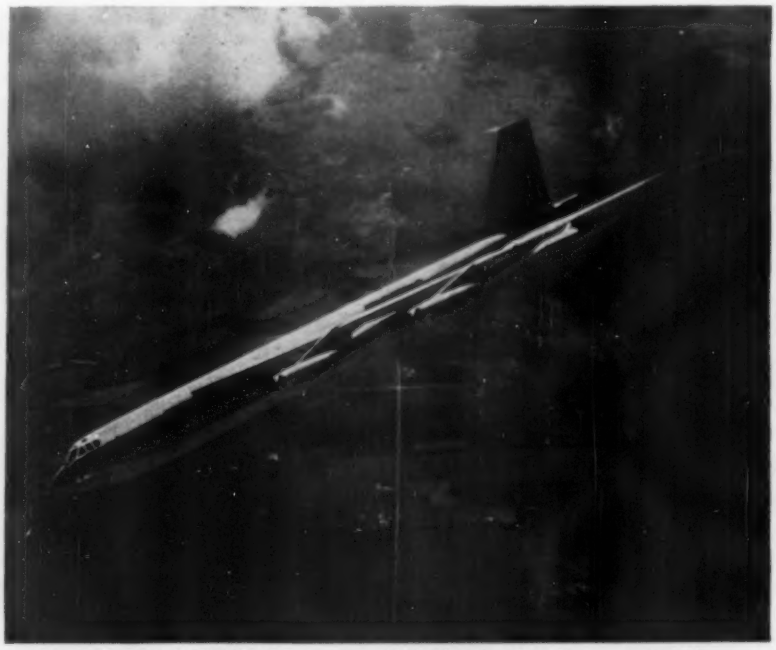
"Export-Import Bank was of great assistance in the first round of sales in the turbine field where the purchasers are major carriers and sound financial risks. The second round of sales therefore leads us into airlines that are not particularly good credit risks and which will need considerable assistance financially."

Light aircraft manufacturers—including Hiller Aircraft Corp., Piper Aircraft Corp., Beech Aircraft Corp., and Cessna Aircraft Co.—urged that the U. S. government press for tariff reductions, particularly in Latin American and European "common market" countries where tariffs in some cases now exceed 50%. A uniform 22% levy is now in prospect for the six "Common Market" countries—France, Italy, Netherlands, Belgium, Luxembourg, West Germany. In most instances this will mean a reduction, but in the case of Germany—which the light plane industry considers its best market—it will result in a substantial increase in the present 4% levy. Industry spokesmen urged that the U. S. seek a uniform level of 10%—instead of 22%—in the common market area.

Tariff Reductions

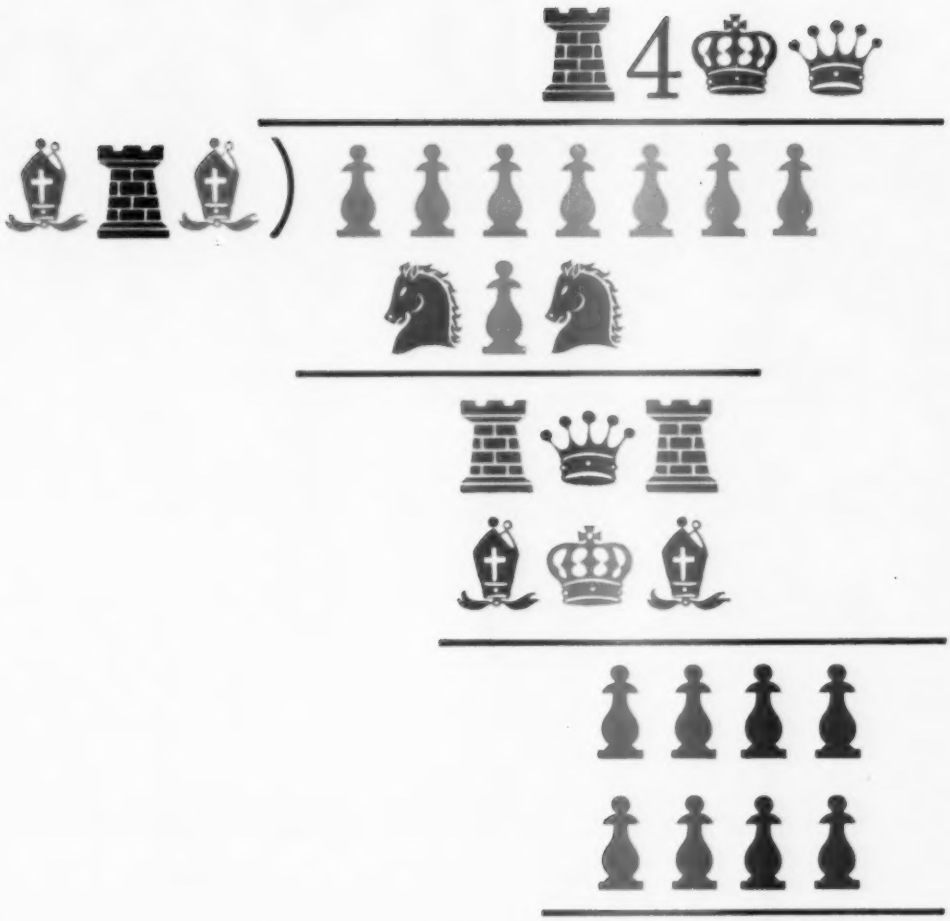
Several U. S. aeronautical manufacturers with interests in the common market countries, it was noted by Commerce spokesmen, are cool to tariff reductions.

Taylor urged that the government expand its organization to meet increas-



Boeing B-52G Leaves SAC Refueling Tanker

Boeing B-25G missile bomber is shown just after it had broken away from a refueling boom, slipping down on the right of the Strategic Air Command tanker. Armament is two Hound Dog missiles. Unrefueled range is 9,000 stat. mi. B-52H is now in production.



CLUE: The sum of the digits of the divisor leaves a remainder of seven when divided by nine, and the sum of the digits of the quotient leaves a remainder of three when divided by nine.

AND LET'S CONSIDER ANOTHER QUOTIENT. It takes shape as men's minds go deep into space. One center of these calculations is Martin-Denver, where successful professionals enjoy full scope from basic research to vehicle design. You will find range, reward, and stature here. Write N. M. Pagan, Director of Technical and Scientific Staffing, Martin-Denver, P.O. Box 179J, Denver, Colorado.

MARTIN
DENVER DIVISION

A 5000° flame takes ten minutes to penetrate a one-quarter inch piece of CDF's new Dilecto RD-105 laminate. The same thickness of cold-rolled steel is pierced in less than forty seconds.

Molded from graphite fabric impregnated with a heat (ablation)-resistant phenolic resin, new CDF grades RD-105 and RD-115 are being evaluated in solid propellant rocket motors.

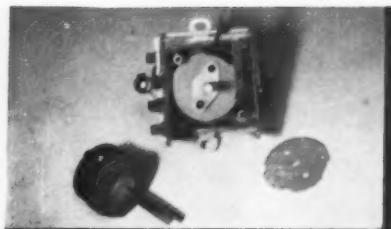
Dilecto laminates are only one family of products from industry's largest selection of non-metallic structural materials and electrical insulations. Vulcanized fibre, silicone rubber and mica, and thermosetting moldings are also supplied by CDF.

CDF can provide both quality and true economy in selecting plastic materials best suited to your needs. Refer to SWEETS PD file or write to us for General Folder 60.

CONTINENTAL-DIAMOND FIBRE

® A SUBSIDIARY OF THE Budd COMPANY • NEWARK 19, DEL.

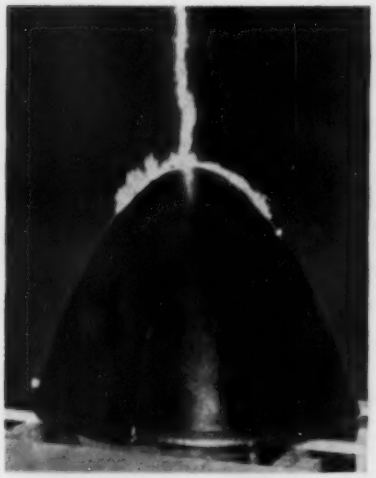
In Canada, 46 Hollinger Road, Toronto 16, Ont.



Moisture-resistant and low cost Dilecto cams for automatic washer and dryer controls.

Dimensionally stable, light weight, oil-resistant Dilecto ball bearing retainer rings.

Easily fabricated paper-base, punching grade Dilecto precision switch insulators.



JetStar Radome Test

Nose radome of Lockheed JetStar executive jet transport is tested for lightning protection by Lightning & Transients Research Institute, Minneapolis. Charge is 1.5 million volts.

ing international air transport competition by establishing:

- **Permanent aeronautical** division in Commerce Department.
- **Foreign Commerce Service,** staffed by qualified trade specialists reporting directly to the Commerce Department, but under the general supervision of State Department's overseas missions.

The government-industry aeronautical conference was attended by 30 representatives of Commerce Department, headed by Secretary of Commerce Frederick H. Mueller and including representatives of the Bureau of Foreign Commerce and the Business and Defense Services Administration. Other government participants included representatives of Export-Import Bank, International Cooperation Administration, State Department, Federal Aviation Agency, and Defense Department. Twenty-seven industry representatives participated.

Continental Borrows Long-Term Funds

Denver—Continental Airlines has borrowed $42 million in a recently completed refinancing program which provides the airline for the first time with long-term institutional funds.

Banks have provided $25.5 million of the new loans, insurance companies and the Ford Foundation another $12.5 million. The remaining $4 million, AVIATION WEEK has learned, was acquired by unsecured notes from Boeing Airplane Co. and Vickers-Armstrongs. Under the revised debt structure, Continental's total indebtedness has increased by $8 million to $54 million.

Terms of the $25.5 million loans are at 5½% expiring Sept. 30, 1965. The $12.5 million loans, at 6.5%, expire Dec. 31, 1972.

Continental was in a negative cash position before the refinancing. Under the program, $34 million in senior debt from banks and equipment trust certificates was retired, and $8 million in new money was available to pay for a fifth Boeing 707-120 and to improve the airline's cash position. The cash position now is positive.

Since early 1955, Continental has borrowed $71 million to buy piston, turboprop and jet aircraft.

English Electric, GE Considering Merger

London—Two of Britain's three largest electric firms—English Electric Co. and General Electric—are considering a merger.

Merger would be by means of a holding company. Combined net assets would be about $495 million, topping assets of the third company, Associated Electrical Industries, worth $465 million.

Both English Electric and GE cover a full range of electrical equipment, from appliances to atomic energy.

...IS WHERE THE MOST ADVANCED TRAINING IN AIR FORCE HISTORY BEGINS. Today, with the rapid strides in aviation technology, the great need in the Air Force is for pilots who are able to keep pace; who can prove their skill and adaptability in the most demanding training student pilots have ever known. Today, the pilots of tomorrow must learn more, faster. So today, after screening, they begin their training in the highly student-oriented cockpit* of a high-performance jet: Cessna's twin-jet T-37, the most advanced primary trainer in Air Force history.

**One of many T-37 features designed to aid the student: side-by-side seating of student and instructor.*

CESSNA

Military Division, Wichita, Kansas

Quick delivery...a specialty at Deutsch! Naturally, we can't make delivery on the 1st if you order on the 7th ... unless you let us use the calendar shown above. But we can promise delivery of catalog items in a week or less from either our eastern or western stock locations. As a matter of fact, we usually ship on receipt of your advance order, without waiting for confirmation. And this goes for our entire line of standard environmental miniature electrical connectors: solder or snap-in types, self-aligning cylindrical and rectangular rack-and-panel models, and hermetics that never leak. If you have a tight production schedule staring you in the face, contact your local Deutschman today. He'll do his best to make delivery yesterday. For location of your nearest Deutschman write for Data File H-10.

DEUTSCH

Electronic Components Division • Municipal Airport • Banning, California

ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

Government Challenged on Cargo Rates

Tulsa, Okla.—A sharp challenge to the federal government to amend air cargo rates to spur a sharp growth for the industry and to operators and manufacturers to promote modern turbine-powered equipment that would provide a major breakthrough in business was voiced here last week by Frank Lynott, Flying Tiger Line vice president-operations.

Stating that purchase of the turboprop-powered Canadair CL-44 all-cargo airplane promises an imminent breakthrough in air freight because its efficiencies will permit Flying Tiger to make a profit hauling cargo now in the almost exclusive domain of surface carriers at rates competitive with these transportation forms, Lynott said it was of "utmost importance" that these advances not be compromised as many siginficant improvements often are.

"We feel that the federal government has a key responsibility in seeing this transition take place," Lynott stated, adding that the fast-moving impact that Flying Tiger expects as a result of CL-44 operation cannot await a three-year general fare investigation. He said that FTL was "elated" to hear that Civil Aeronautics Board will immediately review the air freight rates to see if they are presently justified due to changing conditions, and that this may be accomplished prior to introduction of the new equipment that will make it possible.

Lynott said that Flying Tiger will seek authority, in its soon-to-be-filed cargo tariff, to have the initiative to set and change rates as the day-to-day requirements of competition and industry require, feeling that this is one of the most important keys to survival in the air freight business.

Flying Tiger has firm plans for a tariff that will go down from its present average return of 19 cents per ton-mile to 12 or 13 cents, with commodities not now moving in volume being priced at 6 to 8 cents, Lynott told industry, government and military representatives at the Institute of the Aeronautical Sciences Air Logistics Forum here. "Our studies find 40 billion ton-miles available and now moving by surface at these rates and our CL-44 can make a profit hauling it. . . . That is why we bought them 18 months ago," Lynott stated.

Surveying technical aspects of the air freight problem, Lynott said that ever-increasing performance requirements have penalized the airfreighter in protection of passengers in that segment of industry. He questioned the necessity of Federal Aviation Agency specifications for airfreighters being so close to those for passenger aircraft and noted that FTL has requested FAA to evaluate the economic significance of several thousand additional pounds zero fuel weight, landing weight or even takeoff weight to an operator vs. the "nth degree of curve it often reflects on safety margin."

He noted that a 56% increase in weight for the Douglas DC-6A airfreighter makes the difference between a "fairly good aircraft" and none at all.

Turning to the manufacturer, Lynott asked where in their organization has been the air freight convert? He noted that prior to buying the CL-44, FTL had analyzed every airplane available in the world and failed to convince a manufacturer to build an airplane from the group up for the carrier. "We simply didn't have the buying power," he conceded. "Until there is a 100-plane market, what answer can the manufacturer give you except 'wait'?"

The advent of turbine power makes it possible to design and build an uncompromised pure cargo airplane that

BALL·LOK
POSITIVE LOCKING
QUICK RELEASE
PINS

FAST...SAFE...DEPENDABLE

Cam Lever Style

Buttonhead Style

"T" Head Style

Available in both single acting and double acting styles.

The ideal fastener for applications where parts or assemblies are frequently assembled or disassembled for service or replacement. Also BALL-LOK PINS are widely used as a safety fastener to prevent accidental or premature release of movable assemblies.

For every design requirement where a pin fastener must be easy to insert... quick to withdraw, yet provide positive safety BALL-LOK single acting pins serve best. Five head styles adapt to all design requirements. Pins range from 3/16" (#10) to 1" diameter.

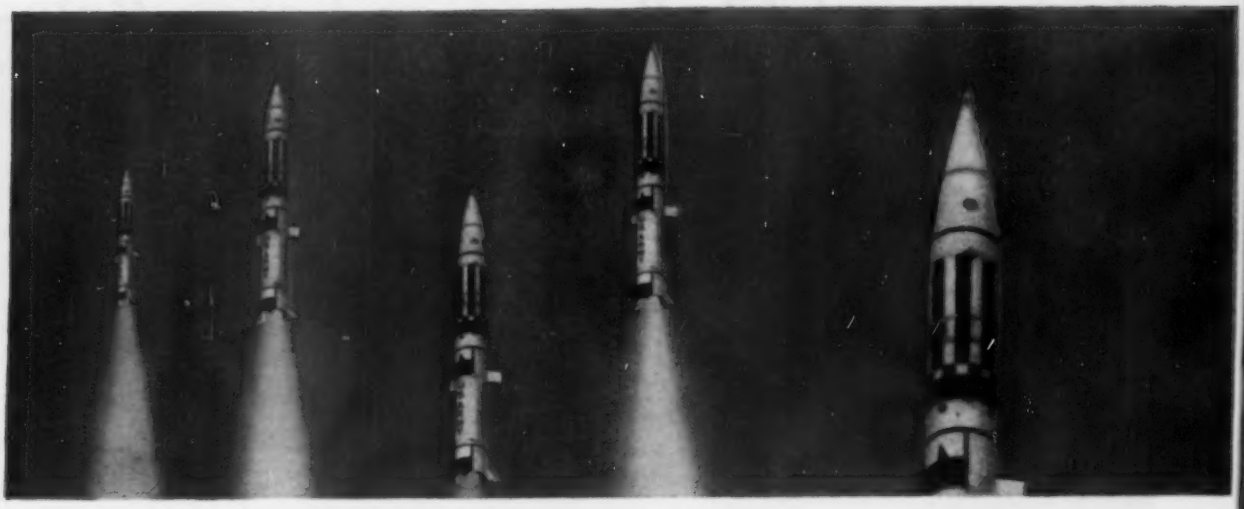
POSITIVE RELEASE UNDER "OVERLOAD" OR "BOUND" CONDITIONS

Double acting BALL-LOK Quick Release Pins combine rugged strength with instant insertion, easy withdrawal and self safetying. In cases where ordinary fasteners may bind in misaligned holes or under heavy loads the added "drive-in" "drive-out" spindle permits forcible release of the pin. Double acting pins are available in "Ring," "T" and "L" head styles. Use the experienced technical knowledge of our engineering staff to help solve your quick release fastener problems.

FOR TECHNICAL DATA—WRITE FOR BROCHURE AV-460

AVDEL, Inc. is the new corporate name for the combined facilities of Aviation Developments, Inc. and D. W. Price Corp., leading manufacturers of quick release pins.

AVDEL INC.
210 SOUTH VICTORY BOULEVARD • BURBANK, CALIFORNIA



INERTIAL GUIDANCE MASS PRODUCTION

Unified facilities turn out stable platforms in volume for Pershing, cut lead time 20%—also offer advanced inertial guidance experience in design and engineering

Knowmanship in Action

Inertial guidance capabilities at E-P extend across three fronts—design, engineering, and production. Our production efficiency is proved by the fact that we are now mass-producing complete inertial guidance systems, including highly-precise air-bearing gyros—"heart" of inertial guidance—for Pershing. We are able to do this, and save 20% in normal lead time, because of advanced techniques, and most modern facilities, coupled with most efficient management.

We have developed space-age techniques that enable us to machine such a difficult material as beryllium to tolerances as fine as 10-millionths of an inch. Our specially-developed "super-clean room" maintains perfect conditions for assembly, test, and calibration of delicate inertial guidance components on a *volume* basis.

E-P KNOWMANSHIP also offers practical advantages in inertial guidance design and engineering. We have a technical staff of over 500 devoted exclusively to solving inertial guidance problems. Our engineering experience includes work with air-bearing gyros that float both gimbal and spinning mass, as well as with liquid-floated gyros and accelerometers. Gimbaling specialists have developed the way to more compact inertial guidance platform packaging.

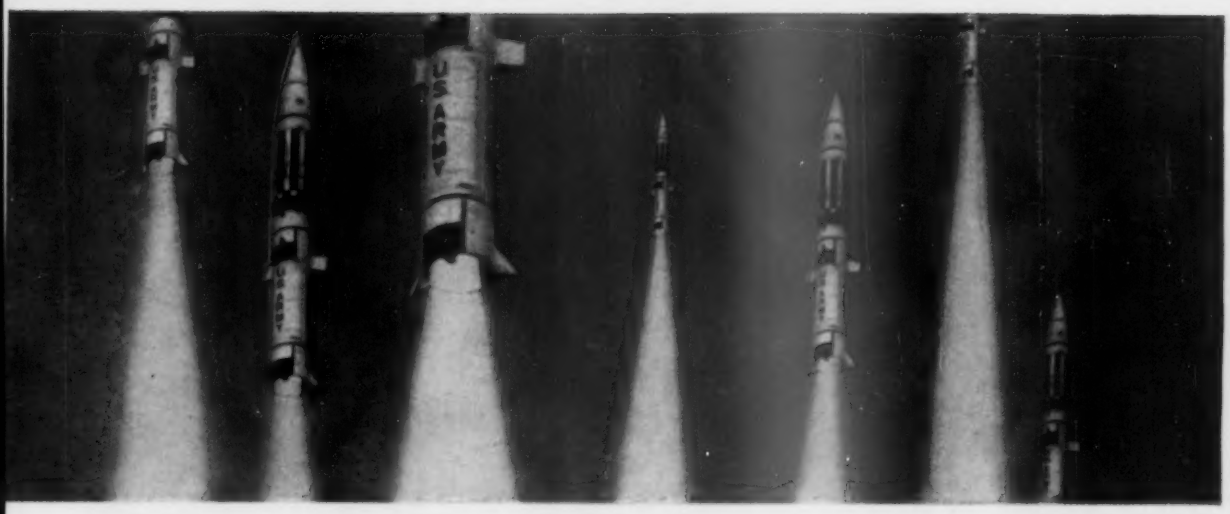
The point is this. With demonstrated production accomplishments—plus practical design and engineering experience—we offer a rare degree of proficiency to apply to *your* inertial guidance needs—whether they be for outer space or under the sea. Why not explore our capabilities! A word from you will bring our complete story to your desk.

TECHNICAL KNOWLEDGE + EXPERIENCED MANAGEMENT + SPECIALIZED CRAFTSMANSHIP = **KNOWMANSHIP**

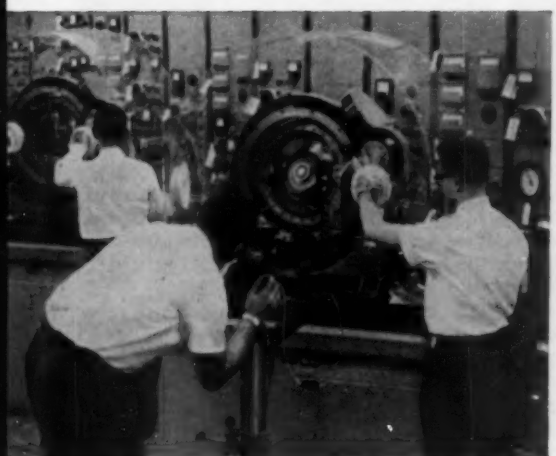
Eclipse-Pioneer Division

TETERBORO, N. J.

THE Bendix CORPORATION



SYSTEMS NOW IN AT BENDIX E-P



SUPERFINE TEST AND CALIBRATION. E-P checkout facilities include: Single axis and planetary sidereal test stands accurate to .005° per hour; indexing heads with an accuracy of ± 2 seconds of arc used for calibrating pendulous integrating gyros.

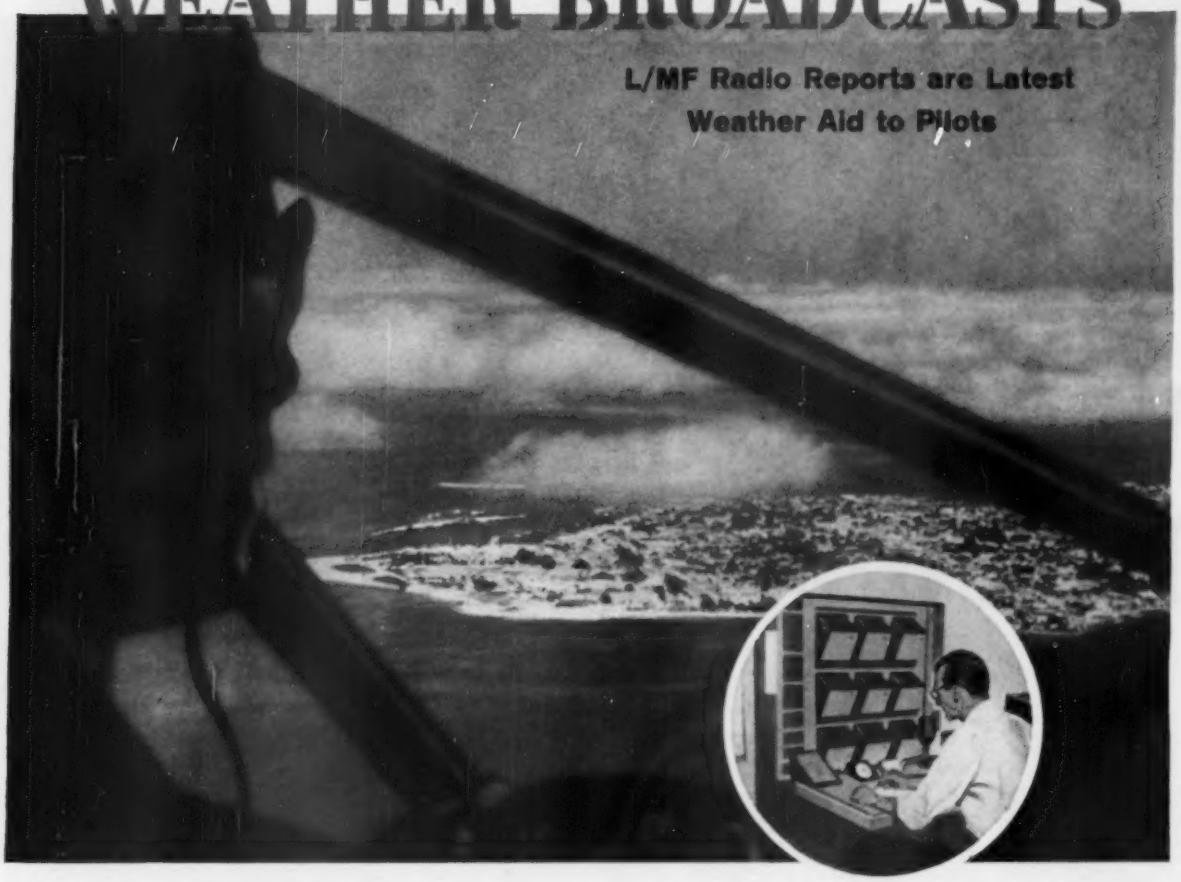
"WORLD'S CLEANEST ROOM" at E-P offers perfect conditions for mass assembly of precise components. In this 55-station, air-conditioned area, all contaminants larger than 1 micron (.000005") are filtered out.

Mobil

FLY WEATHER-WISE

These weather items prepared in consultation with the United States Weather Bureau

TRANSCRIBED
WEATHER BROADCASTS



THE U.S. Weather Bureau and FAA's latest innovation—a low and medium frequency aircraft weather reporting service—is a real boon to VFR planning and flight safety!

Now pilots can tune in on the 200 to 400 KC frequency (L/MF range or H facility) and receive the latest meteorological and Notice to Airmen data. Even owners of the small, relatively inexpensive 3 to 4 wave-band radios covering these Frequencies can pick up this important information. These taped reports and forecasts are presently broadcast continuously by FAA-ATCS stations in 12 cities across the country. After identifying itself, the station gives the weather conditions for a radius of 250 miles, pilot reports (PIREPS), wind aloft data and radar reports, when available—plus reports on actual weather at selected locations within a 400-mile radius. The pilot is kept informed of the fronts and pressure systems for the following 6 to 12 hours, small aircraft warnings in effect in the next 2 hours, and forecasts of significant area and route weather for the subsequent 8 to 12 hours.

Experienced pilots use all of the up-to-date methods that assure safe, sure flights. That's why so many choose quality Mobil products . . . fuels and lubricants that are a result of progressive research and the most modern technology . . . products of unsurpassed performance and dependability! As always . . . *You're Miles Ahead with Mobil!*

FAA-ATCS Stations and their broadcasting frequencies

Chicago (Joliet), Ill.	350 & 257 KC	*Cleveland, Ohio	344 KC
Indianapolis, Ind.	266 KC	Denver, Col.	379 KC
Los Angeles, Calif.	332 KC	Fort Worth, Texas	365 KC
New York, N. Y.	209 KC	Pittsburgh, Pa.	254 KC
Washington, D. C.	332 KC	Boise, Idaho	359 KC
Boston, Mass.	382 KC	Cincinnati, Ohio	335 KC

*Test Basis

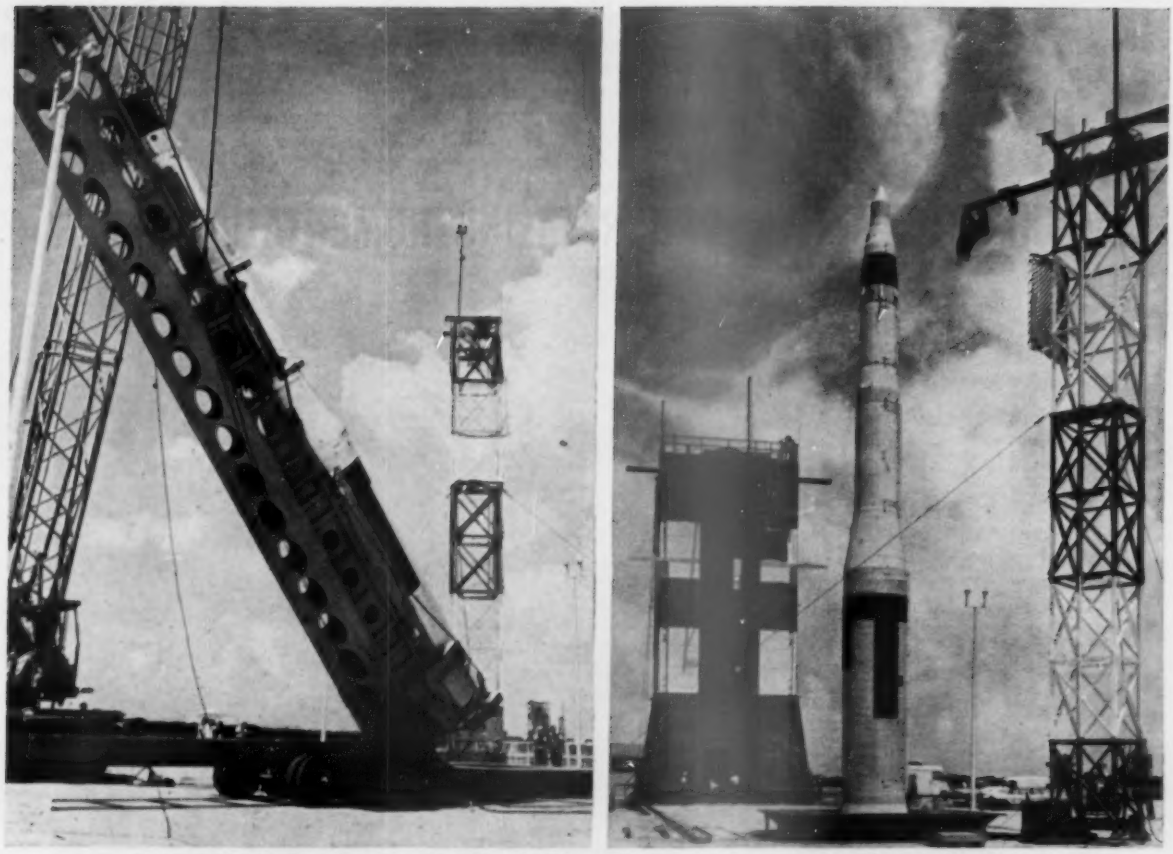
Mobil

MOBILJET FUELS

MOBILGAS AIRCRAFT

MOBILOIL AERO

MOBIL OIL COMPANY, 150 East 42nd Street, New York 17, N. Y.



First Full-Scale and Hard-Site Minuteman Models Shown

First hard-site model of the Air Force Minuteman intercontinental ballistic missile is used to check out ground support equipment at Cape Canaveral, Fla., launching site. At right, first full-scale model of Minuteman aboard its railroad launcher is unveiled at the Air Force Assn. convention held recently in San Francisco, Calif.

can carry freight at ocean rates, he stated. Powerplants have made this revolution possible, but the present speed of development in this direction is on the basis of evolution, he maintained.

He told the audience that for over 20 years the manufacturers have built compromised air freight aircraft and today are hardly better off than when they started and stated that there still is not an air logistics system worthy of the gross national product of the U. S.

Stating that the tempo is changing, the surveys are improving and noting that a railroad—the New York Central—acquired an interest in the Flying Tiger Line "for very significant reasons," he stated that the breakthrough is in motion. "Initiate and apply for new concepts of performance, spend the same effort on payload as you have on passenger comfort . . . and above all, choose an uncompromising director of the program . . . and then give him some authority," Lynott asked.

Turning his eye toward the military, Lynott stated that the military position in logistics is to the commercial air cargo operator that of his grandfather. "They originated the problem . . . throughout history they solved it. Yet today, as incongruous as it may seem and as much money as they have spent on it, I believe they have fallen far short in advancing the arrival of true air logistics."

He stated that the military air cargo funds, though well intended and bitterly fought over by the carriers, have not generated a single self-supporting system, but have kept alive obsolete vehicles such as the DC-4 and C-46.

The hundreds of millions of dollars spent thus far, if directed toward modernization, he noted, could have aided the purchase of 75 to 100 true airfreighters. He cited the present Logair system, noting that it today handles tonnage equal to all the common carriage air freight handled in the U. S. last year, and that this is all moved on obsolete C-46 and DC-4 type aircraft, and only recently did the first requirement emerge encouraging purchase of modern aircraft — the Armstrong-Whitworth AW.650 four-turboprop twin-boom fore and aft loading plane—by Riddle.

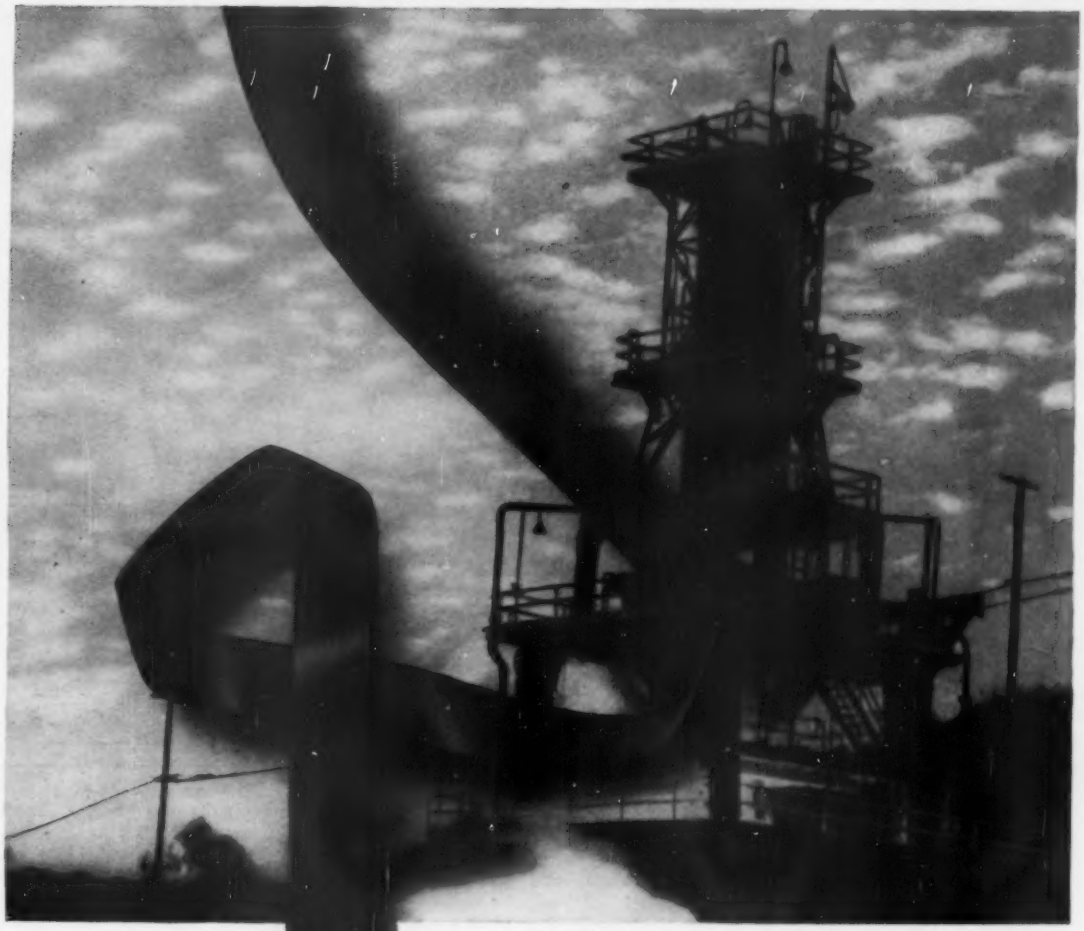
Lynott advocated that the military demand modernization all through its airlift purchasing program, indicating that such a spur will help to encourage growth of a market sizable enough to attract the manufacture of new and uncompromised, turbine-powered freighters.

He also questioned the wisdom of the passenger carriers in creating all-freight fleets from surplus passenger airplanes, because they have, he said, the power to cause a true airfreighter to become a fact. Surplus piston aircraft are not going to be the panacea for this cargo market, he stated, because they simply cannot compete with the turbine even if written off to zero and they will not be able to reduce freight rates as Flying Tiger Line proposes to do when its CL-44 enters its system.

He noted that FTL's equipment modernization plans extend into the terminal area. The Tigers, he said, are incorporating an automated terminal at O'Hare Field, Chicago, into its CL-44 system and he estimates the new facility will reduce cost 35% and ground times by 300%.

WORKING PARTNERS

ROCKETDYNE AND SOUNDCRAFT INSTRUMENTATION TAPES



At North American Aviation's Rocketdyne division, the recording of rocket engine performance on static stands, calls for the use of only the most reliable of instrumentation tapes, like Soundcraft. Why? Because Soundcraft Instrumentation Tapes combine exact physical and electrical properties so necessary to assure absolute reliability of performance—as a direct result of being manufactured in the world's most modern tape plant under the most advanced quality control system.

In short, experience has proven that Soundcraft Instrumentation Tapes *work best* in recording of critical rocket testing operations. Why not let precision-made, error-free Soundcraft Instrumentation Tapes go to work for you? Complete literature on request.

REEVES SOUNDCRAFT CORP. Great Pasture Rd., Danbury, Conn. • Chicago: 28 E. Jackson Blvd. Los Angeles: 342 N. LaBrea • Toronto: 700 Weston Rd.

New Offerings

United ElectroDynamics, Inc., Pasadena, Calif., engaged primarily in the development and manufacture of electronic measurement instruments, particularly telemetry components and systems; environmental, reliability and qualification testing, and field inspection; research, seismic instrument production and field services in the earth sciences, primarily nuclear detection. Offering is 169,500 shares of common stock; 156,000 shares for public sale for the account of the company, and 13,500 outstanding shares by the present holders thereof. Offering price and underwriting terms to be supplied by amendment. Proceeds of the company's sale of stock will be used to pay in full $800,000 of bank indebtedness, and the balance will be added to general funds to be used principally for the carrying of an anticipated increase in inventories and accounts receivable.

Kaynar, Inc., Pico-Rivera, Calif., engaged in the design, manufacture and sale of light weight nuts, principally the "Kaylock" self-locking nut, and pin curl clips for women's hair styling. Offering is 300,000 shares of common stock; 100,000 shares for public sale by the company, and 200,000 outstanding shares by the present holders thereof. Offering price and underwriting terms to be supplied by amendment. Proceeds of the company's sale of stock will be added to the company's working capital. To the extent of $235,000, working capital which has been used since Jan. 31, 1960, to pay off two loans aggregating that amount will be replaced. When the company's subsidiary, Kayner (France) S.A.R.L., Moussey (Vosges), France, is in full operation it is expected it will require about $250,000 of working capital which the company will supply.

Clark Cable Corp., Cleveland, Ohio, engaged in the manufacture and development of electronic, electrical and mechanical systems and components principally for use by the U.S. government. Offering is 222,500 shares of common stock; 127,500 shares for public sale for the account of the company, and 95,000 outstanding shares by the present holders. Offering price is $4 per share. Of the proceeds, $136,000 will be used to repay existing obligations to banks incurred in 1960 to retire trade accounts payable and for other working capital purposes; $22,000 to retire the company's promissory notes held by Capital Industries, Inc.; the balance for working capital and other corporate purposes.

The Technical Materiel Corp., Mamaroneck, N. Y., engaged in the design, manufacture and sale of components and complete systems for high-frequency radio communication, its equipment being used primarily in long-range, high-frequency radio communication. Offering is 120,000 shares of common stock; 50,000 shares for public sale by the company, and 70,000 outstanding shares by the present holders thereof. Proceeds of the company's sale of stock, approximating $750,000, will be used in part to construct a new plant on a site to be determined (but probably in Westchester County, N. Y.); the remainder to be added to working capital to carry additional inventories and accounts receivable.

Carco Industries, Inc., Philadelphia, Pa., organized under Delaware law in July, 1960, for the purpose of acquiring all the capital stock of Carco Industries, Inc., a Pennsylvania corporation, which was organized in December 1954. All the outstanding shares of the Pennsylvania corporation are being acquired in exchange for 200,000 shares of the new company which, through the Pennsylvania subsidiary, will engage in the manufacture, assembly, sale and installation of a variety of metal products including assembly and production line equipment, ground-support and missile and aircraft handling equipment and pipe fittings. Offering is 150,000 shares

From Analytical Study to
OPERATIONAL HARDWARE

SAWYER
New, Small, Single-Stage
Centrifugal BLOWER

0" to 30" H_2O Pressure
0 to 35 SCFM

Low Flow, High Pressure
High Speed Unit for Airborne Ventilation ... or
Closed Circuit Systems

•

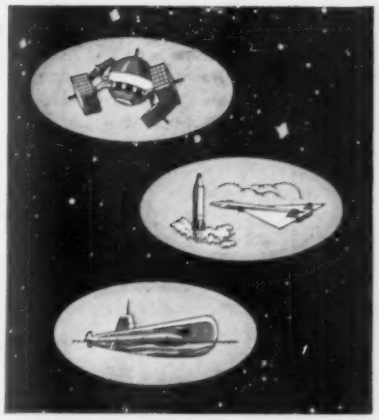
Unique Rotor Designs

•

Pressure Flow & Power Curves Available

Analytical Design
Heat Transfer • Fluid Flow
Mechanical Design
Fan and Blower, plus associated support equipment
Crew Environmental System

For Further Information write
A. J. SAWYER CO., Inc.
597 Oakwood · E. Aurora, N. Y.



TAPCO OFFERS

The expanding Engineering Department of the TAPCO GROUP of Thompson Ramo Wooldridge Inc. offers new opportunities for career-minded engineers and scientists. TAPCO's product diversity, equipment and systems for a wide spectrum of defense needs, from space to undersea projects, provides a new meaning to the phrase "job security".

Openings exist now in the fields of:

- Aero-Thermodynamics
- Airframe Structural Analysis
- Bearings and Seals
- Electrical Power Systems
- Electronic Circuit Design
- Electro-Mechanical Reliability
- High Temperature Plastics
- Mechanical Stress Analysis
- Mechanical Testing
- Metallurgical Development
- Military Operations Research
- Power Systems Development
- Standards and Specifications
- Thermodynamics
- Underwater Acoustics.

TAPCO is located in greater Cleveland, close to gracious suburban living and to three fine universities affording evening study opportunities.

If you think your engineering skills would be of interest to us, send a resume to

Mr. R. J. Theibert,
Employment Manager
Box 60-1.

TAPCO

THE TAPCO GROUP OF
Thompson Ramo Wooldridge Inc.
23555 Euclid Avenue
Cleveland 17, Ohio

of common stock for public sale at $5 per share. Of the proceeds, $10,000 will be used to purchase additional property adjacent to the present plant in northeast Philadelphia; $85,000 for the erection of a building thereon; $105,000 for additions to and improvements in the company's plant, machinery and equipment; $100,000 for payment of income taxes for the fiscal year ended Aug. 31, 1960; balance of about $299,750 will be added to working capital for carrying of increased inventories and accounts receivable.

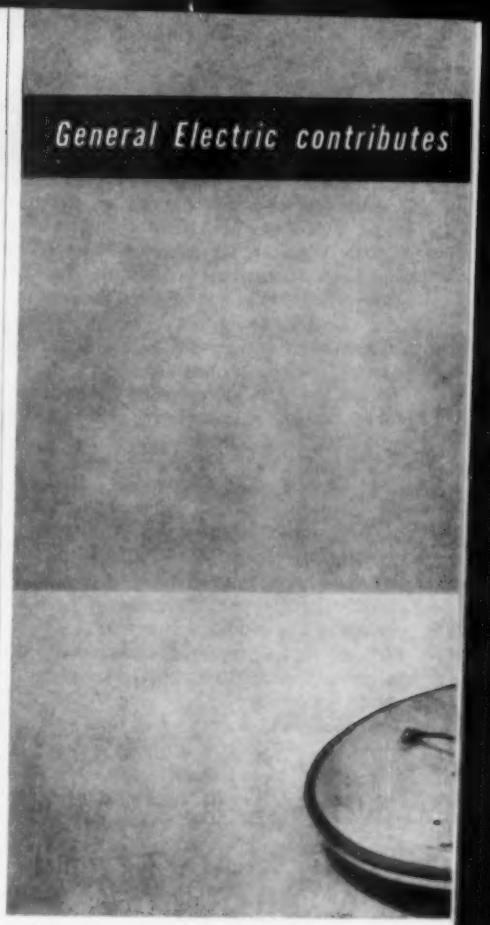
Premier Microwave Corp., Port Chester, N. Y., engaged in the design, development and production of microwave components, specifically coaxial and waveguide components and printed circuit analogs of such components. Organized in 1940 under the name Premier Tool and Instrument Corp., the name was changed to Premier Microwave in Aug., 1960; in May, 1960, the company acquired all the outstanding stock of an affiliate, Portchester Instrument Corp., which now is operated as a subsidiary. Offering is 100,000 shares of common stock for public sale; offering price and underwriting terms to be supplied by amendment. Proceeds will be used in part to repay some $29,000 of bank borrowings and $84,900 of notes payable to officers, which borrowings were made to provide additional working capital; balance will be used to supplement working capital and for other general corporate purposes.

Summers Gyroscope Co., Santa Monica, Calif., engaged in the design, development, manufacture and sale of various gyroscopic and indicating instruments, related equipment and systems for the navigation and control of aircraft and short-range missiles. Offering is 6,403,215 shares of common stock; 5,702,878 shares are held by Atlas Corp. and are to be offered by that company for subscription by its stockholders at the rate of one share of Summers stock for each two shares of Atlas common; 700,337 shares are held by Mertronics Corp. and are to be offered by that company for subscription by its stockholders at the rate of one share for each share held. Subscription price to be 75 cents per share; record dates to be supplied by amendment. Purpose of the offering is to effect a divestiture by Atlas and Mertronics of all their interest in the company in order to dispose of proceedings pending before the Civil Aeronautics Board arising out of the interlocking relationships existing between Atlas, which controls an air carrier, and the company, which is deemed by the CAB to be engaged in a phase of aeronautics. Since Atlas is the holder of approximately 41% of the outstanding voting stock of Mertronics, divestiture on the part of Mertronics is also required to effect complete termination of such interlocking relationship.

Electronics International Capital, Ltd., Hamilton, Bermuda, has applied to the SEC under the Investment Company Act for permission to register as an investment company and to make a public offering of its securities in the United States. The company was incorporated by a special act of the Bermuda Parliament; it was organized for the purpose of engaging in business as a closed-end non-diversified management investment company investing in securities of foreign electronic companies, among others, those traded on the stock exchanges of Toronto, Montreal, London, Amsterdam, Frankfurt, Paris or Johannesburg. The company contemplates a public offering of shares through an underwriting group to obtain at least $22,500,000 for its investment purposes. Charles E. Salik is listed as president and board chairman; he owns 81% of the stock of Electronics Investment Management Corp., which owns all of the stock of Electronics International Management, Ltd., which will serve as investment adviser of the applicant company.

Drexel Dynamics Corp., Philadelphia, Pa.; organized in 1957, the company is engaged in research, development and production operations in the fields of mechanics, electronics, optics and functional systems, embracing the mathematical and physical sciences. Among other things, the company is currently engaged in the production, under contract with the U. S. Navy, of jet engine lifting and positioning trailers, in the design, development and prototype manufacture of aircraft special weapons truck for the Navy, in the design and manufacture of direct projection system for use with existing simulation equipment in the evaluation of collision avoidance techniques for the Federal Aviation Agency, in supplying engineering services for the U. S. Transportation Command, and in the manufacture of radar antenna bearings as a subcontractor. Offering is 100,000 shares of common stock for public sale at $6 per share. Of the proceeds, estimated at $511,740; $100,000 will be used for continuation of product development program; $16,000 for payment of notes; $395,740 as additional working capital.

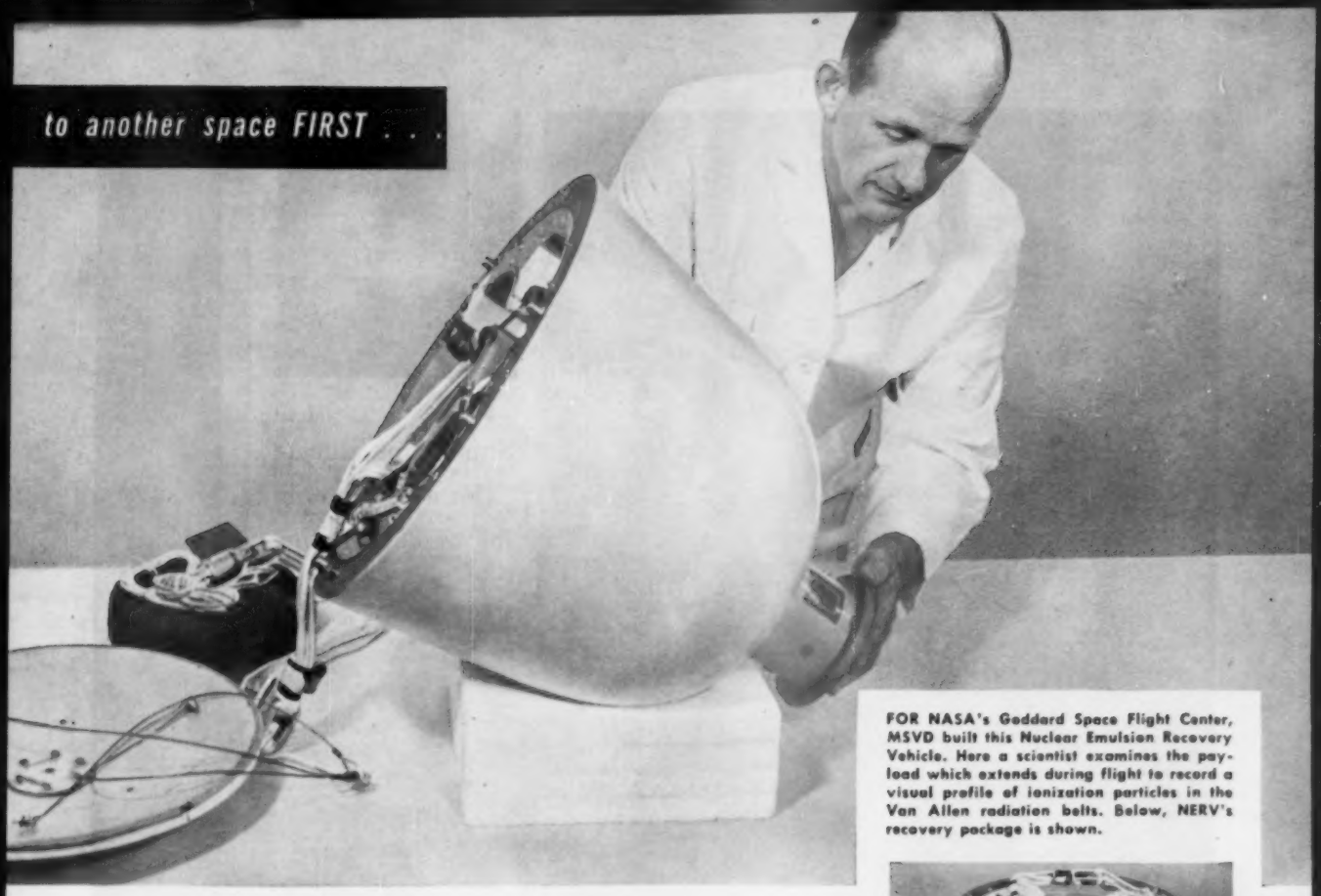
Melpar, Inc., Falls Church, Va., engaged in research, development and production of electronic equipment for the U. S. government and its major prime contractors; in the electronics field, the company's efforts are especially directed to the areas of recon-



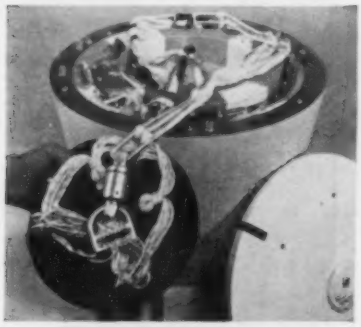
How NERV Space

NASA's Nuclear Emulsion Recovery Vehicle, developed by General Electric Missile and Space Vehicle Department, is highest space probe ever to be recovered.

Another major step in space exploration was achieved September 19 when NASA's first NERV—Nuclear Emulsion Recovery Vehicle—was successfully recovered after a 1200 nautical mile-high flight into the Van Allen space radiation



FOR NASA's Goddard Space Flight Center, MSVD built this Nuclear Emulsion Recovery Vehicle. Here a scientist examines the payload which extends during flight to record a visual profile of ionization particles in the Van Allen radiation belts. Below, NERV's recovery package is shown.



Returns Highest Radiation Measurements

belts. NERV brought back detailed measurements of the belts' radiation intensity.

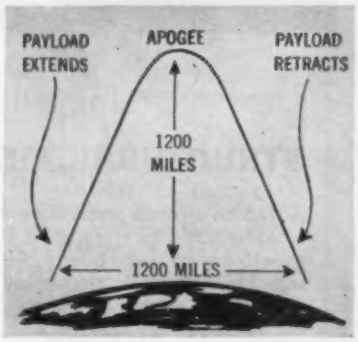
Carrying a nuclear emulsion payload deep into space, NERV "photographed" tracks of the belts' charged particles in ranges from 5 Mev upward. Precise measurements of this radiation must be obtained before optimum shielding can be designed for manned space vehicles.

Recovery of the vehicle after flight—rather than relying only on telemetered information — permits scientists to analyze the nuclear emulsion directly. Thus they acquire a clearer picture of the composition of the belt, the intensity of the charged particles, their velocities, distribution and direction of movement.

General Electric's Missile and Space Vehicle Department designed and built the Nuclear Emulsion Recovery Vehicles for the National Aeronautics and Space Administration's Goddard Space Flight Center.

NERV is readily adaptable to many research missions . . . where exposure of the payload to the space environment and recovery after flight is desired.

To learn more about NERV and other MSVD programs leading toward man's entry into space, write to Section 160, General Electric Missile and Space Vehicle Department, Philadelphia 1, Penna. 160-82



MISSION PROFILE is illustrated above. After burnout of the rocket's four stages, a linear actuator extends the emulsion package. Payload is exposed through its apogee of approximately 1200 nautical miles and until the vehicle is within approximately 250 nautical miles of the earth upon return.

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A DEPARTMENT OF THE DEFENSE ELECTRONICS DIVISION

Stimulating climate ...for career growth, for outdoor living.

Seattle's 200 miles of shoreline stimulate distinctive home planning

Immediate, long-range openings at Boeing for

STRUCTURAL, MECHANICAL AND AERONAUTICAL ENGINEERS

Advanced aircraft projects of the future are expanding steadily at Boeing's Transport Division. This continuing growth has created a number of exceptional career openings for structural, mechanical and aeronautical engineers. Long-range assignments are available immediately on advanced commercial flight projects. In addition, training assignments are available, on a selective basis, to engineers in other fields who wish to apply their capabilities to aircraft projects.

At Boeing, builder of the famous 707 and 720 jetliners, you'll be working with the world leader in the field of multi-jet aircraft. You'll be backed by unexcelled research facilities, including the largest, most advanced wind tunnel installation in private industry. You'll be working in a dynamic career environment that's conducive to rapid advancement.

The Boeing Transport Division is located in the uncongested Pacific Northwest, noted for mild year-round climate, nationally famous recreational facilities, excellent schools and housing, and healthful outdoor Western living for the whole family.

Drop a note now, giving a resume of your educational and experience background, to: Mr. Robert W. King, Transport Division, Boeing Airplane Company, P. O. Box 707-90A, Renton, Washington.

TRANSPORT DIVISION **BOEING**

naissance, simulation and training systems, data handling, fuzes and radar beacons communications, antennas, and countermeasures. Offering is 217,000 shares of capital stock, for subscription by holders of the outstanding common stock of Westinghouse Air Brake Co. at the rate of one share of the company's stock for each 20 shares of Westinghouse, held of record on Sept. 9, 1960; subscription price and underwriting terms to be supplied by amendment.

All of Melpar's outstanding 2,250,000 shares of capital stock are owned by Westinghouse Air Brake Co.; Westinghouse also holds a $4,000,000 note of the company. Proceeds of the sale will be applied to the repayment of a portion of the $4 million note.

Cryogenics, Inc., Washington, D. C.; organized in May, 1959, under Florida law, the company intends to engage in the design, development, manufacture and sale of instruments and instrumentation systems for the handling and control of cryogenic materials (or gases which have been liquefied by cooling to the range of cryogenic temperatures, −150 to −460F). The company is new in the field, and has no factory or equipment. Offering is 236,000 shares of common stock; 175,000 shares to be offered for public sale by the company at $2 per share, and the additional 61,000 shares to be sold to promoters at 10¢ per share. Of the proceeds, $5,000 will be used to repay a bank loan in that amount; $55,000 to pay certain salaries; $32,000 for operating expenses; $6,600 for purchase of land in Fredericksburg, Va.; $123,000 to build and equip a research and development laboratory thereon; the balance for working capital.

In July, 1960, John Mahr and Herbert C. Lazarus of John R. Maher Associates, Gordon R. Molesworth of Molesworth Associates, Richard W. Ince, and the firm of Bull & Low, acquired 14,500, 14,500, 5,000, 5,000 and 22,000 shares respectively, at 10¢ per share.

Molesworth Associates will render advice in public relations and sales promotion for one year at a monthly fee of $1,000, plus disbursements, the fee to be paid quarterly in stock at the rate of $2 per share.

International Diode Corp., Jersey City, N. J., organized under New Jersey law in August, 1959, and engaged in the business of manufacturing and selling diodes. In October, 1959, the company acquired from its president, Peter Toong, the assets and business of Qutronic Semi-Conductor Corp., by whom Toong had been employed in connection with the development and manufacture of diodes. Offering is 42,000 shares of 6% non-cumulative convertible preferred stock for public sale at $8.00 per share. Proceeds will be used to finance the establishment of a staff of production and sales engineers; to finance new product development; to purchase additional equipment; to add to working capital.

Beech Missile Target Makes First Flight

New Beech PD75-4-1 remote-controlled missile target vehicle has completed its first successful flight test at White Sands Missile Range, N. M. An improved version of the Beech KDB-1 Navy target, the PD-75-4-1 differs in having a 145-hp. Continental TSIO-200 four-cylinder engine, compared with the earlier 120-hp. six-cylinder McCulloch engine and a heavier gross weight than the KDB-1. Dimensions, many parts and ground support system are compatible between the two vehicles for maximum economy; aim is to improve performance with no increase in unit cost, according to Beech engineers. PD75-4-1 is a Beech private venture. Initial flight of the new vehicle, made at reduced power as programed, was made from a Beech-developed zero-length launcher, using JATO for takeoff assist.

PHYSICAL METALLURGISTS

Join one of industry's most progressive teams in exploring the metallurgical frontiers of supersonic flight.

Here are unusual opportunities in applied research for experienced metallurgists who would like to assume increased responsibility and expand their "sphere of influence."

Successful applicants must have the ability to organize and direct the work of others. These positions afford exceptional opportunities for advancement in an expanding materials development program.

Background Preferred: Graduate Metallurgical Engineer with at least four years experience including development or application work in one or more of the following specialties:

Titanium Alloys
Hot Work Die Steels
Superalloys
Refractory Metals
Mechanical Metallurgy
(Sheet Metal Forming)

For more information please write to: Mr. A. K. Bowman, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

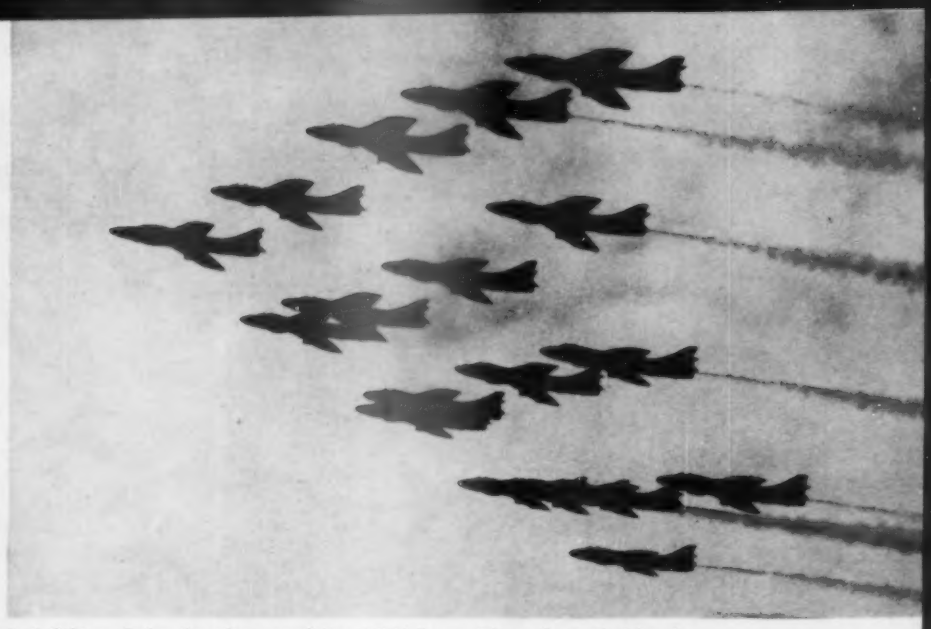
Squadron begins show with 18-plane loop over Farnborough.

Hunter quartet executes scramble takeoff at close intervals (above).

RAF Treble One

Eighteen plane formation splits into two divisions for alternate passes

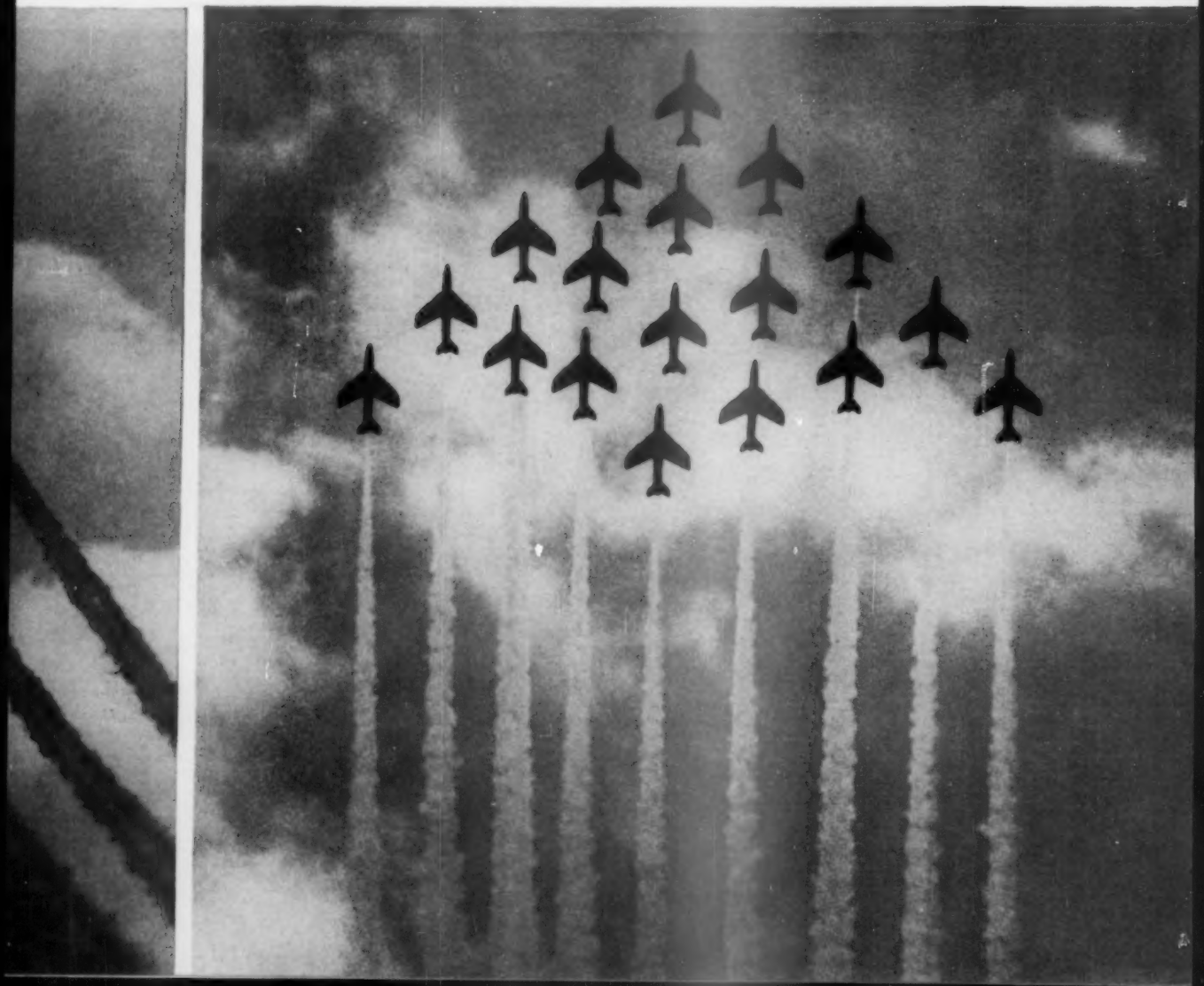
Internationally famous acrobatic show of No. 111 Squadron, Royal Air Force, had its final performances at the British Farnborough air show last September. Squadron is exchanging its highly maneuverable subsonic Hunter Mark 6 fighters for the supersonic English Electric Lightning, necessitating abandoning the acrobatic capability that pioneered full squadron acrobatic formations. Treble One squadron was the first to do a full squadron loop, actually using 22 planes with four borrowed from another squadron for maximum performance and the peeling down to smaller formations in an aerial strip tease routine with maneuvers becoming more intricate as the size of the formations decreased. For its Farnborough finale Treble One introduced several new routines, including splitting its opening 18-plane squadron formation into two "Big Nine" formations to provide alternate acrobatic passes over the crowd. Among other new formations shown at Farnborough in the finale were the Double Draken pattern emerging during the execution of a nine-plane loop and aimed at duplicating wingplan of the Swedish fighter and the Farmer, showing the general shape of this supersonic fighter of the Soviet air force. Treble One is commanded by Squadron Leader Peter Latham, a World War II veteran.

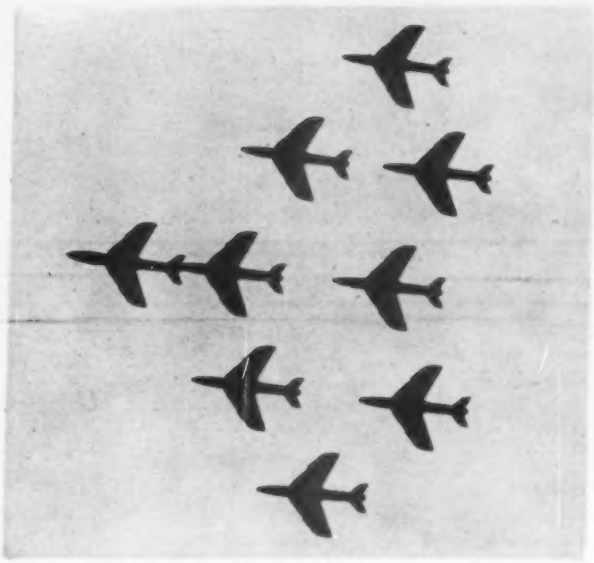


Tightly packed formation of 18 Hunter Mark 6 fighters flashes by after completing initial loop with smoke trails (above).

Squadron Flies Acrobatic Finale at Farnborough

Squadron formation rolls over top of loop against rare scattered cloud background. Note formation precision.

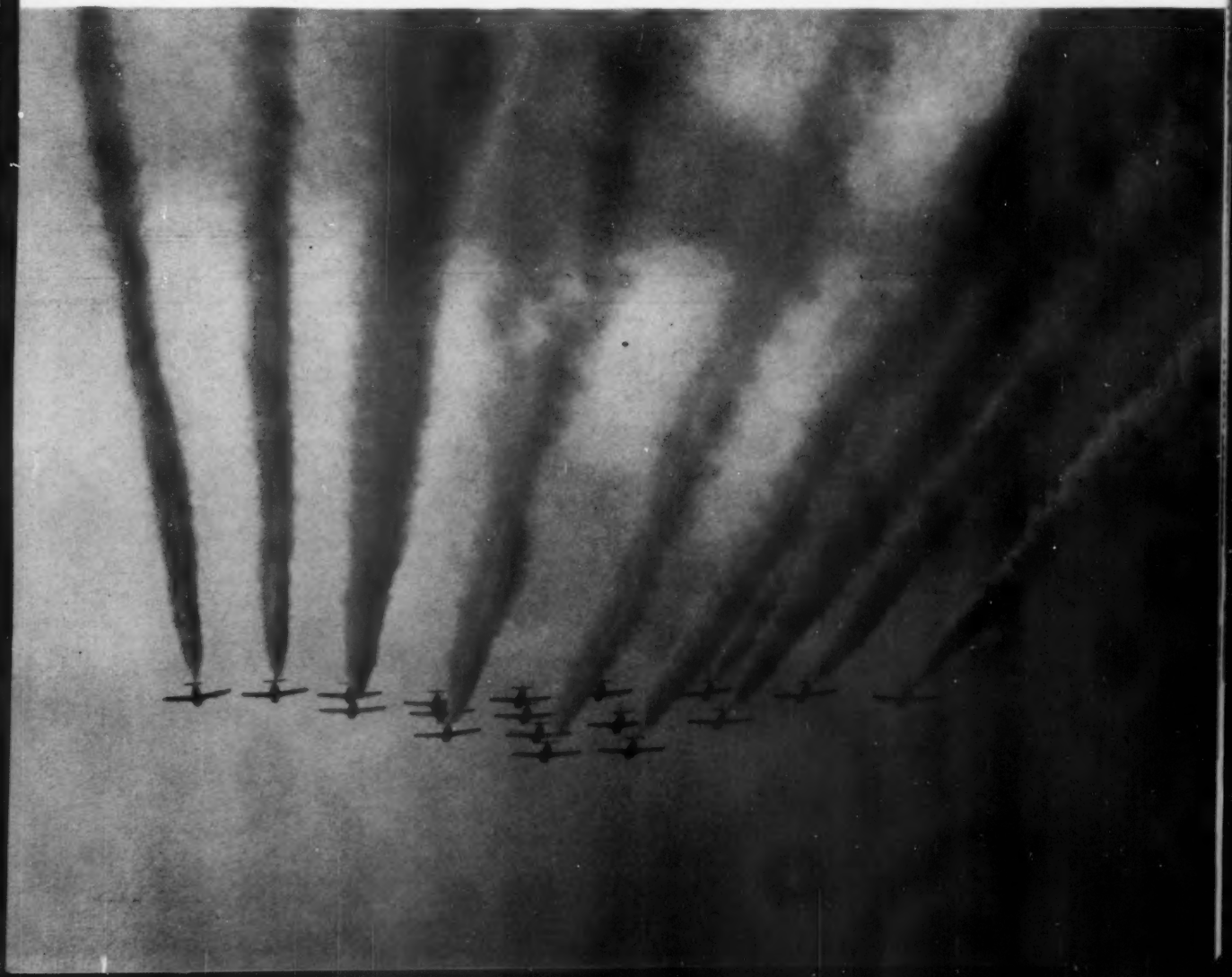




Big Nine is basic formation from which special acrobatic maneuvers are executed after opening.

Formation aims at simulating planform of Swedish air force Draken double delta fighter.

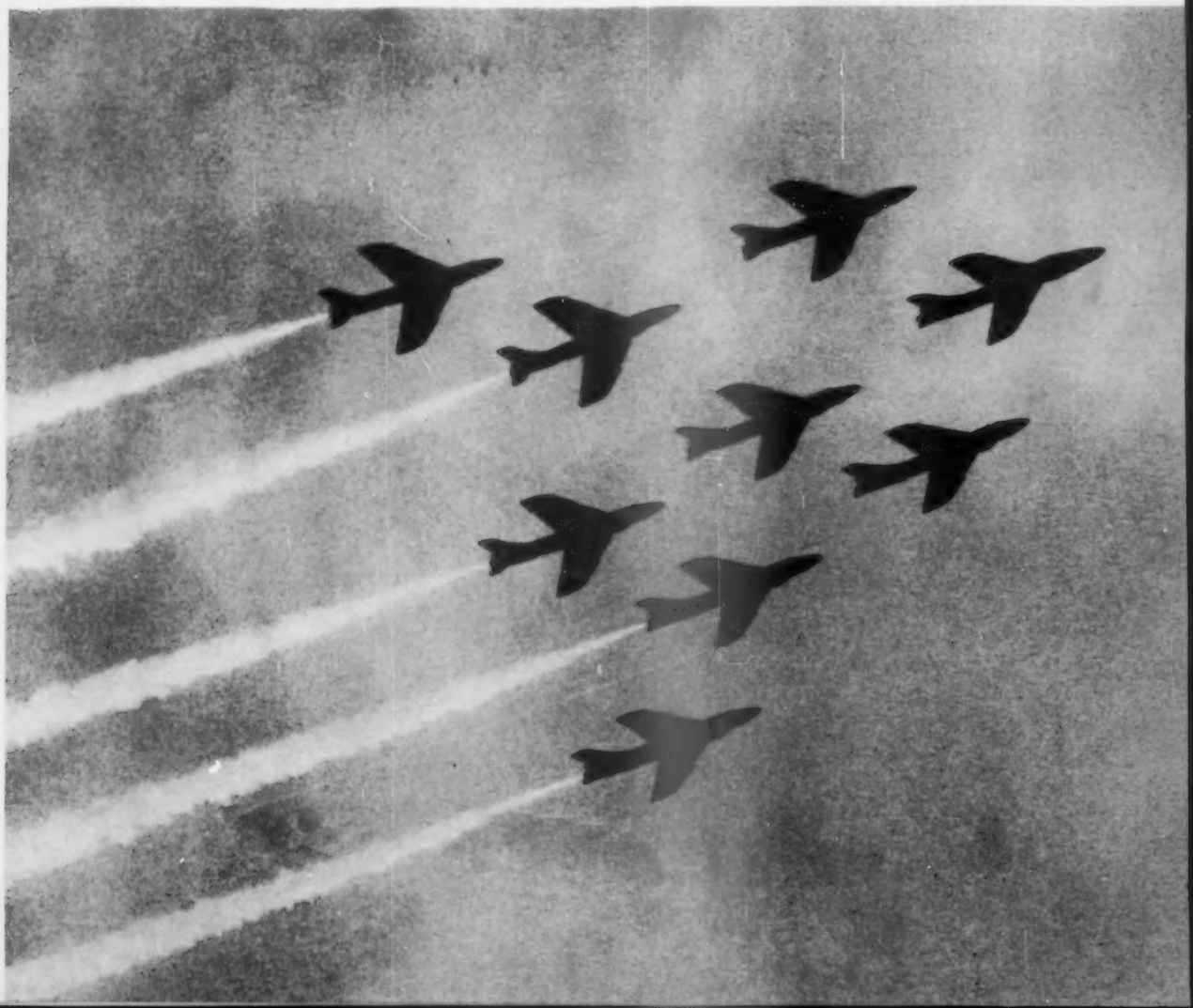
Trailing smoke, 111 Squadron emerges from bottom of formation loop and begins climb to start formation split into two "Big Nines."



Wineglass formation emerges during loop that began with three line astern groups.

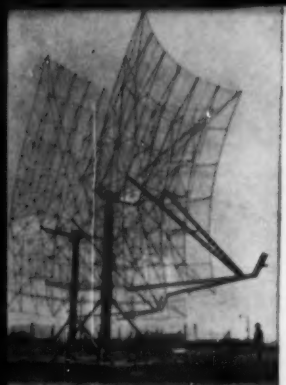
Farmer formation formed during loop aims at shape of Soviet supersonic fighter.

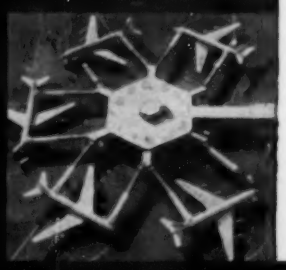
Treble One squadron Hunters switch from special formations into basic "Big Nine" for maneuvering between acrobatic passes.



SIXTH ANNUAL
Aviation Week

BUYERS'





THE ONLY COMPLETE BUYERS' GUIDE SERVING
THE ENTIRE AEROSPACE INDUSTRY

THE STANDARD PURCHASING REFERENCE OF THE AEROSPACE MARKET

MAJOR PRODUCT CATEGORIES INCLUDE:
AIRCRAFT • AVIONICS
SPACE VEHICLES & MISSILES
SUPPORT EQUIPMENT & ACTIVITIES
AIRPORT & AIRLINE EQUIPMENT

GUIDE ISSUE

AVIATION WEEK's Annual Buyers' Guide is one source for buying information in all segments of the dynamic aerospace industry. It's on the engineer's desk...at his fingertips...readily accessible...with needed information.

The new 1961, 6th Annual Edition, now in preparation, is more complete and essential than ever before, containing expanded listings on new products and companies in new areas of the total market.

It will contain over 50,000 manufacturers' product listings in 1,800 product categories. In addition to being quick and easy to use, the BUYERS' GUIDE includes complete listings of government procurement agencies telling: Where to go; Who to see; What they buy.

BUYERS' GUIDE usage was demonstrated in a survey conducted eight months after publication of the 1958 edition.

71% of respondents still had their copy
60% of this group referred to it at least once a month

This means your advertising is available to the purchaser or specifier at the moment buying information is needed. Its constant reference value and year long life offers multiple exposure of your advertising.

Advertisers' product listings are bold faced and include a reference to the page number of their advertising. In addition to an alphabetical advertisers' index, there is a "product" advertisers' index. To supply you with key industry sales leads the BUYERS' GUIDE contains Reader Service cards.

If you sell to the aerospace industry, your advertising message belongs in the BUYERS' GUIDE—as well as your company's product listings.

PUBLISHING DATE: Mid-December

CLOSING DATE: November 15, 1960

ABC PAID CIRCULATION 78,983

A McGraw-Hill Publication
330 West 42nd Street, New York 36, N. Y.

Aviation Week and **Space Technology**

British Accident Investigation Report:

Controllers Blamed in Viscount Crash

The following British civil aircraft accident report was submitted by J. W. Duggan, deputy chief inspector of accidents, Accidents Investigation Branch, Ministry of Aviation, to the Minister of Aviation.

The report concerns the crash of a British European Airways Corp. Viscount 802 on Runway 28L at London Airport on Jan. 7, 1960, at 1922½ hr. GMT. There were no fatalities.

The accident occurred on landing at London Airport in conditions of fog after a scheduled flight from Dublin. The flight was uneventful until after the aircraft had crossed the runway threshold when it ran into an area of much reduced visibility. The nosewheel unit was damaged when contact with the runway was made and the aircraft then traveled for a distance of 500 yd. on the mainwheels with its nose rubbing on the runway before it came to rest. Fire broke out and the occupants evacuated the aircraft without injury. The fuselage was subsequently almost completely burned out.

The aircraft was constructed by Vickers-Armstrongs (Aircraft), Ltd., at Weybridge in 1957 and was registered in the name of British European Airways Corp. It had flown for a total of 5,299 hr. There was a valid certificate of maintenance and the aircraft and its engines had been maintained in accordance with an approved maintenance schedule. The loading was within the permissible limits and the calculated landing weight was approximately the maximum permissible. The certificate of airworthiness was renewed on July 9, 1959, and was valid.

Pilot Experience

Capt. E. S. Linstead, aged 39, held a valid airline transport pilot's license with instrument rating and an endorsement in Group 1 for Viscount aircrafts. He also held a general flight radiotelephony operator's license. At the time of the accident he had flown for a total of 9,149 hr. of which over 3,000 were in command of Viscount aircraft. He and the first officer had flown for three hours during the preceding three days.

First Officer A. Forman, aged 37, held a valid commercial pilot's license with instrument rating and an endorsement in Group 1 for Viscount aircraft. He also held a restricted flight radiotelephony operator's license. He had flown for a total of 8,020 hr. of which 1,773 were on Viscount aircraft.

The visibility at London Airport had been poor all day because of fog. The following weather observations were made by the Meteorological Office:

	1916 hr.	1925 hr.
Wind	Calm	Calm
Cloud	Sky clear	Sky clear
Met. visibility	75 yd.	25 yd.
Present weather	Thick fog	Dense fog

The following runway visual range observations for Runway 28L were logged by the runway controller:

1610 hr.		700 yd.
1649	"	850 "
1708	"	900 "
1728	"	700 "
1905	"	600 "
1910	"	400 "
1920	"	250 "
1922	"	100 "
1923	" less than	100 "

These figures, taken in conjunction with those recorded for Runway 23R, indicate that the deterioration had advanced across the airport from the west or northwest and had spread almost to the threshold of Runway 28L at 1922 hr.

The Flight

As the visibility at London Airport had been poor throughout the day and because of the weather forecast the captain took on sufficient fuel at Dublin to enable him to return if necessary although his alternates were Hurn and Jersey. Pre-departure inspections were made by an Aer Lingus engineer and by the two pilots during the turnaround at Dublin and these inspections revealed no defects in the landing gear. The takeoff and flight as far as the runway threshold were without incident.

The captain made frequent checks of the London visibility from the time of first radio contact with London Airways at 1829 hr. He also listened to the weather broadcasts on the Flight Information Region frequency and asked for additional information. The RVR on Runway 28L given to him at 1829 hr. was the 700-yd. figure measured at 1728 hr. This figure was again given at 1858 hr., two minutes before the descent was begun over Bristol. The deterioration to 400 yd. was passed to him at 1910 hr. Because the captain had decided to carry out a monitored approach the first officer controlled the aircraft during the descent and approach.

At 1914 hr. London Director (radar) took over control of the aircraft for a radar positioning to an ILS approach for Runway 28L monitored by precision radar. The RVR for that runway was again given as 400 yd. and the London approach controller, who was on the same frequency, added "Rest of London weather. Surface wind calm. Met. visibility 200 yd. in fog. No low cloud." A few seconds after 1918 hr. London Director said "The visibility seems to be dropping. I'll give you a short turn-on. Continue descent to 1,500 ft." This remark regarding visibility was made spontaneously by the London Director concerned and was based on his observation of lights through a window in the tower. At 1920 hr., when the aircraft was five miles out turning onto final approach, frequency was changed to London Precision. Due to the fact that the aircraft had passed through the ILS beam to the south when turning onto the runway heading and was not closing with the center-line quickly enough in view of its close proximity to the threshold, the captain asked London Precision to take over at 1921½ hr. when the aircraft was two miles from touchdown and 400 ft. left of the center-line. London Precision gave a turn of 10 deg. to the right followed by one of five degrees to the left as the aircraft came onto the center-line one mile from touchdown on the glide path. The final transmission by London Precision was "Three-quarters of a mile from touchdown. Left, left further five degrees. On the center-line. Twenty feet below the glide path. On the center-line. Half a mile from touchdown. Approach completed. Out." The time signal for 1922 hr. injected into the tape recording occurs between "path" and "On." At 1922½ hr. just as the aircraft came to rest on the runway the captain called on the R/T "We have a crash. We have a crash." The crash alarm was given to the fire and rescue services.

Visibility Improves

The captain stated that the visibility during the approach appeared to him to be considerably better than 400 yd. and that he could see the first bar of the approach lights when about three-quarters of a mile from it. As the aircraft passed over that bar, he could then see the green threshold lights together with some of the contact lights on each side of the runway. At this point, when still above the break-off height of 250 ft., he took over control from the first officer feeling quite confident that he could safely complete the approach and landing solely by visual reference. As he crossed the threshold at normal height and speed he still felt confident that he had more than the BEA minimum visibility of 400 yd. Both he and the first officer thought that a normal flareout was made and that the touchdown was rather heavy. Immediately afterwards the captain had the impression of running into a wall of fog and at once applied full braking. As he did so he heard a thud and felt a lurch and realised that the aircraft was going down onto its nose. He ordered the first officer to shut down the engines and carry out fire drill. When the aircraft came to a halt it began to fill with smoke and the cabin crew and the pilots ensured that all the passengers were safely and quickly evacuated.

The captain saw a small pool of liquid burning under the fuselage around the nosewheels. He obtained the CO_2 extinguisher from the cockpit but as this had only a short funnel-shaped nozzle and would only operate when in an upright position he could not get close enough to the flames to use it in view of the nearness of the

fuselage to the ground. However there was undoubtedly a more serious fire taking hold in the forward luggage bay above the nosewheels. Because all the doors and two rear emergency exists were open and because of the hole made in the underside by the nosewheels a chimney effect was produced in the fuselage which rapidly intensified the fire and accelerated its course rearward. By the time the first fire service appliances arrived a fierce fire had burned through the top of the fuselage to the rear of the cockpit and had spread as far back as the front of the passenger cabin.

Examination of Wreckage

When the nose of the aircraft was lifted in the early hours of the morning of Jan. 8 it was seen that the nosewheel unit downlock was engaged even though its housing had been torn out and that the retaining structure had failed in such a way as to suggest a severe drag load. The unit, which normally retracts forward, had been forced backward and upward through the underside of the fuselage making a substantial hole in the forward luggage bay. The seat of an intense fire appeared to be in the neighborhood of this hole and the fire had then burned rearward above floor level as far back as the tail unit and had almost completely destroyed the fuselage. The wings were not damaged and were untouched by fire.

The first marks on the runway that could be attributed to the aircraft were those of the four propellers, the pattern of which indicated that when these marks were made the aircraft was slightly right wing down and was astride the center-line. They began at a distance of about 330 yd. from the runway threshold. There was evidence of a subsequent slight bounce soon after which the first trace of the nosewheel tires appeared. These tires did not burst until affected by the fire. No marks that could be identified with the mainwheels were found. There was nothing to suggest that the nosewheel unit had struck anything before contacting the runway.

Subsequent Examination

The fractured parts of the nosewheel unit were submitted to laboratory inspection and test. Each fracture was examined and all were found to be similar, each having the appearance typical of tensile failure. There was no evidence of fatigue and the physical properties of the materials were normal for the specifications concerned.

No pre-crash defect or malfunctioning could be found in the nosewheel unit. It was correctly aligned and locked down on impact with the runway.

The nosewheel tires were too badly damaged by fire for any conclusions to be drawn from them. Examination of the mainwheel tires showed no unusual features other than crease marks on the side walls of the starboard tires. These crease marks were most severe on the outside wall of the outer tire and were almost unnoticeable on the inner wall of the inner tire. There were no crease marks on the port tires. The marks were indicative of a heavy landing with the starboard wing down.

The most significant damage caused during the collapse of the nosewheel unit was the fracture of the main hydraulic pipe feeding the steering jacks. Hydraulic oil at a high temperature and pressure would then have been released in the form of spray onto the tires and surrounding structure and probably onto some of the baggage in the forward hold. The escape of the hydraulic oil is considered to be a prime factor in the fire which ensued. Both torsion links (light alloy forgings) of the nosewheel unit showed evidence of frictional heat of between 550 and 600C and they had been half rubbed away. They could thus have provided the necessary ignition source.

The very short distance after the threshold at which the propeller marks were found and the height at which the aircraft had crossed the threshold (obtained from radar and runway controllers) were together indicative of a landing with little or no flareout.

Consideration of all the evidence therefore suggested that the aircraft contacted the runway nosewheel first in a right-wing down attitude. In the Viscount 802, with the fuselage datum at −1 deg., i.e. nose down, the nosewheels and mainwheels would touch down simultaneously on landing while at −2 deg. the nosewheels would touch down with the mainwheels approximately six inches clear.

Energy Absorbed

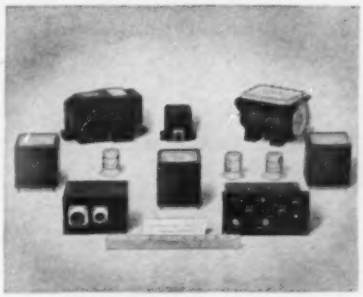
If the nosewheels contact the runway before the mainwheels the energy required to be absorbed by the nosewheel unit is considerably greater than that in an orthodox landing. In this condition and assuming a drag force at the nosewheels of 0.4 times the vertical wheel load the energy to be absorbed by the nosewheel unit would be approximately 62% greater than the corresponding energy of the normal landing. Similarly the high drag condition at wheel spin-up would be increased. These results are brought about solely by the attitude of the aircraft on touchdown and are independent of velocity. If either the vertical velocity, which has the greater effect, or the forward velocity is increased the loads on the unit would be further increased. Thus, if the speed were 110 kt. and the angle of approach 3 deg. the vertical component of velocity would be 9.75 fps. but if this were increased to 11 fps. the energy increase would be 21% for the increase in velocity. In a nosewheel-first landing, therefore, the energy to be absorbed by the nosewheel unit would become approximately 1.21 x 1.62 x the design energy resulting in a total increase of 96%. The corresponding loads would be increased in about the same ratio.

As the design vertical velocity of 10 fps. is the maximum for which the structure is designed and as the theoretical breaking load is produced by 1.5 times this figure, it follows that the loads imposed in a nosewheel-first landing are more than enough to break the structure.

Evidence obtained from a previous Viscount accident in which the identical nosewheel unit attachments were severed indicated that the leg would not necessarily then collapse as it would be supported by the bulkhead immediately behind it. From this and from the captain's evidence, it is considered probable that following the fracture of the retaining structure the nosewheel unit collapsed as soon as full braking

Pioneer the future at

Honeywell Aero



Challenging career opportunities await you at Honeywell, where advanced gyro reference systems, such as the all-attitude system shown here, are being developed. Current openings include:

SYSTEMS ANALYSTS

BSEE, MSEE, or BS or MS in physics to work on systems for space vehicle control and development of components for space vehicle equipment. Experience in any of the following fields desired: guidance and control systems; satellite development; systems management; ground to space communications; telemetery; space environment; ground computation and data processing; overall systems knowledge and understanding.

BSEE, MSEE, or BS or MS in physics to work on general gyro systems and their applications in space control and guidance systems work. Programs involve high-level applications on projects similar to: Titan guidance and control system; the Agena B; the Discoverer; and Project Mercury stabilization control system.

BSEE, MSEE, Physicists or Astro Physicists to work on component applications for space vehicles. Experience in digital computation, transistor circuitry, gyro development and background in miniaturization and reliability controls desired.

To discuss these or other openings, write Mr. James H. Burg, Technical Director, Dept. 832, Aeronautical Division, 1433 Stinson Blvd., Minneapolis 13, Minn.

Honeywell

H Military Products Group

To explore professional opportunities in other Honeywell operations, coast to coast, send your application in confidence to H. K. Eckstrom, Honeywell, Minneapolis 8, Minn.

New programs in Chance Vought's Astronautics and Electronics Divisions have created attractive new positions for engineers and scientists. Because this company- and government-sponsored research is using the most advanced concepts as starting points, only exceptionally well-qualified personnel can be assigned.

THESE ARE HIGH-LEVEL OPENINGS

There will be other new positions as more Vought divisions enter the programs. Presently, the following activities in two divisions are primarily involved:

ASTRONAUTICS DIVISION

Astrionics
Space Sciences
Systems Engineering
Reliability
Operations Analysis

ELECTRONICS DIVISION

Advanced Electronics
Research & Development
Systems and Operational Analysis
Antennas
Automatic Systems
Reliability

Qualified candidates desiring a truly responsible position in any of these fields, please write *Professional Placement Office, Chance Vought, P. O. Box 5907, Dallas, Texas.*

CHANCE VOUGHT

was applied since a considerable additional down load would then have been imposed upon it.

The minimum RVR for this approach and landing is laid down in the BEA Operations Manual as 400 yd. There are two definitions in the manual which are relevant to this minimum. They are:

"Approach Ban Visibility is that runway visual range, or, where this is not available, meteorological visibility, below which a pilot must not commence or continue an approach at the aerodrome which it is reported, except in case of emergency.

"Approach Ban. An approach shall not be commenced, and if already commenced, shall not be continued, where the runway visual range (or if this is not available, the meteorological visibility) notified to the captain is less than the approach ban visibility prescribed for that particular approach."

At the specified critical height of 250 ft. the captain was of the opinion that he had adequate visual reference to continue his approach and since he had been given an RVR of 400 yd. there was no reason why he should not continue his approach to land. If, however, he had been given the deterioration of RVR to 250 yd. he would have had no option but to overshoot.

Visibility Measurement

At London Airport RVR is measured by the runway controller from the runway control vehicle. By night a row of special lights is provided for the purpose and the controller counts the number of lights he can see, then refers to a table of figures from which he reads off the RVR. Under the system in use at the time of the accident he should then pass the figure obtained by direct telephone line to aerodrome control in the control tower. There, the air controller should ensure that the figure is (1) broadcast on tower frequency, (2) called out to the ground movements controller sitting close by, and (3) telephoned to approach control two floors below. The ground movements and approach controllers must then broadcast the RVR on their respective frequencies if they have any traffic. As an aide-memoire the four controllers concerned each maintained a runway visual range form on which they entered the time and the RVR. All but the ground movements controller's copy of these forms were obtained for the day of the accident and they show the following figures for Runway 28L:

RUNWAY CONTROLLER		
1905 hr.		600 yd.
1910 "		400 "
1920 "		250 "
1922 "		100 "
1923 "	less than	100 "
AIR CONTROLLER		
1905 hr.		600 yd.
1910 "		400 "
1920 "		250 "
1921 "		100 "
1922 "	less than	100 "
APPROACH CONTROLLER		
1911 hr.		400 yd.
1922 "		100 "
1923 "	less than	100 "

(Before 1905 hr. the RVR had been 700 yd. for 1½ hr.)

From these it can be seen that the deteriorations at 1905 hr. and 1920 hr. to 600 yd. and to 250 yd. respectively do not appear on the approach controller's copy. Examination of the relevant R/T recordings revealed that he did not transmit either of them or the 100-yd. deterioration and that the ground movements controller passed the 600-yd. and the 400-yd. deteriorations, repeating the latter figure at 1923 hr. and 1927 hr.

The last RVR passed to the aircraft was 400 yd. given by London Director at 1915 hr. In order to establish the reasons for the omissions, statements were taken from those concerned.

The air controller stated that at 1920 hr. he logged the 250-yd. RVR on receiving it from the runway controller and that he believed that he then broadcast it, passed it by telephone to approach control and called it out to the ground movements controller. Very shortly afterwards the runway controller passed him 100 yd. RVR and mentioned that the aircraft had not yet been given the 250-yd. observation. The air controller not only logged all the observations, as shown in the table, but he also broadcast all of them as soon as he received them except for the 100-yd. RVR which he first telephoned to approach in view of the runway controller's comment and which was quickly followed by the further deterioration to less than 100 yd.

The ground movements controller stated that he received no notification of change of RVR after the 400-yd. observation until shortly after the accident when he heard that the RVR was less than 100 yd.

The No. 1 Director stated that no RVR was passed to him between the 400-yd. and 100-yd. observations and that when he received the latter at 1922 hr. he was going to give it to the precision controller (No. 2 Director) sitting close by but noticed that the latter was then giving final instructions to the aircraft and so decided that it was unwise to interrupt. On completion of the talk-down a few seconds later he considered that it was then too late to influence the pilot's decision to land and so refrained from saying anything. He wrote the 1922 hr. and 1923 hr. RVR entries on the approach control copy of the RVR form.

Entry Made

The approach controller said that he made the 1911 hr. entry of 400 yd. on the form on receipt of a telephone message from the tower. He also stated that he did not leave his position and heard of no other RVR until about the time the aircraft landed when he thought a figure of 100 yd. was mentioned.

From the above it can be seen that the evidence is conclusive as to why the 100 yd. RVR was not given to the aircraft but that the evidence concerning the 250-yd. RVR is conflicting.

The tape recordings showed that throughout the hour preceding the accident the air controller and the approach controller had very little traffic on their respective channels and that the ground movements controller was extremely busy on his channel.

The first airport fire service vehicles to reach the aircraft did so about nine minutes after the aircraft came to rest some 700 yd. from the fire station. Upon receipt of

the emergency call from ATC at 1923 hr. the station fire officer, who thought that the visibility was about 700 yd., went on ahead in a rescue tender with a driver followed by two water and two foam tenders and an ambulance. He became lost in the dense fog and did not reach the aircraft until more than 30 min. later. The ambulance driver found the aircraft first and by ringing the bell guided two of the appliances which were reported by the ambulance driver by radio as at work at 1932 hr. The other two appliances arrived shortly afterwards by which time the fire had spread well into the cabin. Later, a CO_2 tender arrived from the north side area followed by another CO_2 tender and a pump escape from the fire station. When the two last-named vehicles reached the scene the main fire had been extinguished although there were small fires still burning in the nose and rear fuselage. The first four appliances had by then run out of water. However, the fire had been prevented from spreading to the wings and hence to the fuel. The efforts of the crews of the two CO_2 tenders and the pump escape succeeded in controlling the burning areas that remained. Further water was required for the process of damping down so search was made for hydrants. The nearest were about 300 yd. away and their position was known to the firemen but due to the fog they were not found until about 2030 hr.

In accordance with London Airport's emergency procedures certain Middlesex County Council Fire Service appliances were called out. They are required to provide the reserves of water and are also responsible for connecting up to the hydrants. The first two of these appliances reached the rendezvous point on the south side of the airport at about 1950 hr. and the remainder arrived shortly afterwards. Ministry of Aviation Constabulary were responsible for guiding them to the scene of the accident but were unable to do so because of the fog. Eventually a marshaling van led them and they arrived at 2040 hr. by which time the fire was virtually out except for one or two small pockets.

Observations

Because of the conflicting evidence given by the air traffic control officers the source of the failure to pass the 250-yd. deterioration to the aircraft cannot be ascertained. This failure was the prime cause of the accident. The deterioration to 100 yd. was not passed to the aircraft because No. 1 Director withheld it on his own initiative.

The result of these failures was to leave the captain in the belief that he had an RVR of 400 yd. for landing. If the 250-yd. figure had been given to him as it should have been, he would have had ample time in which to overshoot as he was about four miles out when this information was available. It would have been just possible in the few seconds remaining for the 100-yd. figure to have reached him and he might still have overshot. As it was he landed when the RVR was 100 yd. or less.

The Manual of Air Traffic Control contains the following instructions in the "Approach Control Radar" chapter, under a paragraph headed "Weather Information."

"Any revised or additional information that becomes available while the aircraft remains under radar control shall be passed to the aircraft. If, however, such information is received when the aircraft is in the concluding stages of final approach, it shall only be passed if a deterioration has occurred which the Radar Controller considers likely to affect the safety of the aircraft."

The No. 1 Director stated that although he did not at the time know of this instruction, he fully appreciated that the deterioration he withheld affected the safety of the aircraft. It must nevertheless be borne in mind that the last-minute decision would not have been forced upon him if the 250-yd. deterioration two minutes earlier had been passed to the aircraft.

The idea of runway visual range was put forward by a committee of inquiry under Lord Brabazon in 1951. In the report it was said that "The purpose of informing a pilot of the runway visual range when low visibility exists is to acquaint him with conditions along the runway which, even on his approach, he may not be able to judge for himself. In low, dense fogs, in particular, it is possible for a pilot to be encouraged to attempt a landing by virtue of the adequate visual reference provided by high intensity approach lights, yet the ground visibility be so low as to make a landing hazardous. These facts point to the conclusion that these weather conditions are the most dangerous a pilot can experience in a landing operation."

In Civil Aviation Information Circular No. 32/1959 entitled "Visual Guidance During an Approach to Land" there appears the following:

"A low layer of fog through which ground or lights may be seen relatively clearly when the aircraft is well above it will result in the guidance decreasing as the aircraft descends: the shortening of the length of the ground pattern seen ahead may appear to the pilot as if there had been a nose-up change of pitch and may induce him to steepen his descent."

This effect could well have brought about a nosewheel-first touchdown, especially as it would have been accentuated by the sudden and unexpected change of density of the fog on crossing the threshold.

Although both the captain and the first officer believed that a flare-out had been made and although the captain believed that the aircraft was on the ground before he had the impression of running into a wall of fog and before applying the brakes hard, the other more positive evidence derived from the radar and runway controllers and from the propeller marks on the runway suggests that the aircraft's descent path was not checked and that the aircraft must have entered the reduced visibility just after crossing the threshold. The precision controller had continued to watch the aircraft on his screen after completion of the precision approach and said that it appeared to be on the center-line and on the glide path up to touchdown. The runway controller said he saw the aircraft pass him at a height of about 20 to 30 ft. His vehicle is situated about 150 yd. along the runway from the threshold and 75 yd. from its left-hand edge. The first marks of impact, those of the propellers, could only have occurred after partial collapse of the nosewheel and they occurred only 330 yd. from the thresh-

work in the fields of the future at NAA

STRUCTURAL DESIGN ENGINEERS

Two years engineering college plus experience desired. Will be engaged on wing and fuselage design.

STRESS ENGINEERS

Rigorous design requirements necessitate extensive structural investigation of the influence of high temperatures and unconventional external loadings. Stress engineers concerned with such structures will have the opportunity to utilize their technical knowledge to the fullest extent in the development of new analysis methods. Experience plus degree preferred.

For more information please write to: Mr. A. K. Bowman, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

Examining a beryllium sphere that has been machined to tolerances finer than 15 millionths of an inch to form the rotor of an electrically suspended gyro.

Stimulating career opportunities await you in the

Honeywell–Aero
Marine Systems Group

The continued expansion of Honeywell's Marine Systems Group has created a number of important new openings. This group is assigned the interesting and stimulating task of developing new electrically suspended gyros and submarine inertial systems using these advanced gyros. Openings include:

INERTIAL SYSTEMS ANALYST: Mathematician or engineer with strong background in vector analysis, operational calculus, matrix algebra and related techniques, to carry out analysis of inertial systems configurations including error evaluation.

DIGITAL SYSTEMS AND LOGIC DESIGNERS: BSEE or MSEE for design and development of electronic data processing equipment. Familiar with digital logic techniques at current state of the art; capable of organizing computing systems to perform various tasks including logical design and critical parameter specifications. Also engineers familiar with digital to analog data conversion.

ELECTRONIC ENGINEER: Electrical engineering degree plus experience in miniaturized semi-conductor electronics development. To design servo, pickoff, and other electronics for use with gyros and accelerometers.

ENGINEERING PHYSICIST: Physicist with practical and theoretical understanding of mechanics, magnetism and electricity to analyze and develop inertial sensors of novel and original design. Also experimental physicist with experience in the development of small, precise electro-optical devices.

MECHANICAL ENGINEER: BSME with 3 to 5 years' experience in extreme precision fabrication techniques to work on the alignment and stable mounting of precision optical-mechanical instruments.

INERTIAL COMPONENTS ENGINEER: Familiar with inertial component specifications and available sources to conduct component evaluations for marine systems.

To discuss these or other openings, write Mr. James H. Burg, Technical Director, Aeronautical Division, 2600 Ridgeway Road, Minneapolis 40, Minn., Dept. 826.

Honeywell

Military Products Group

To explore professional opportunities in other Honeywell operations coast to coast, send your application in confidence to H. T. Eckstrom, Honeywell, Minneapolis 8, Minn.

old. With any degree of flareout at the speed concerned, the aircraft would have touched down much farther along the runway than it did.

In November, 1958, the airport authorities submitted a proposal for the installation of an improved system for disseminating RVR. Largely because this requirement became linked with one for displaying other information a new system was not installed until Mar. 9, 1960.

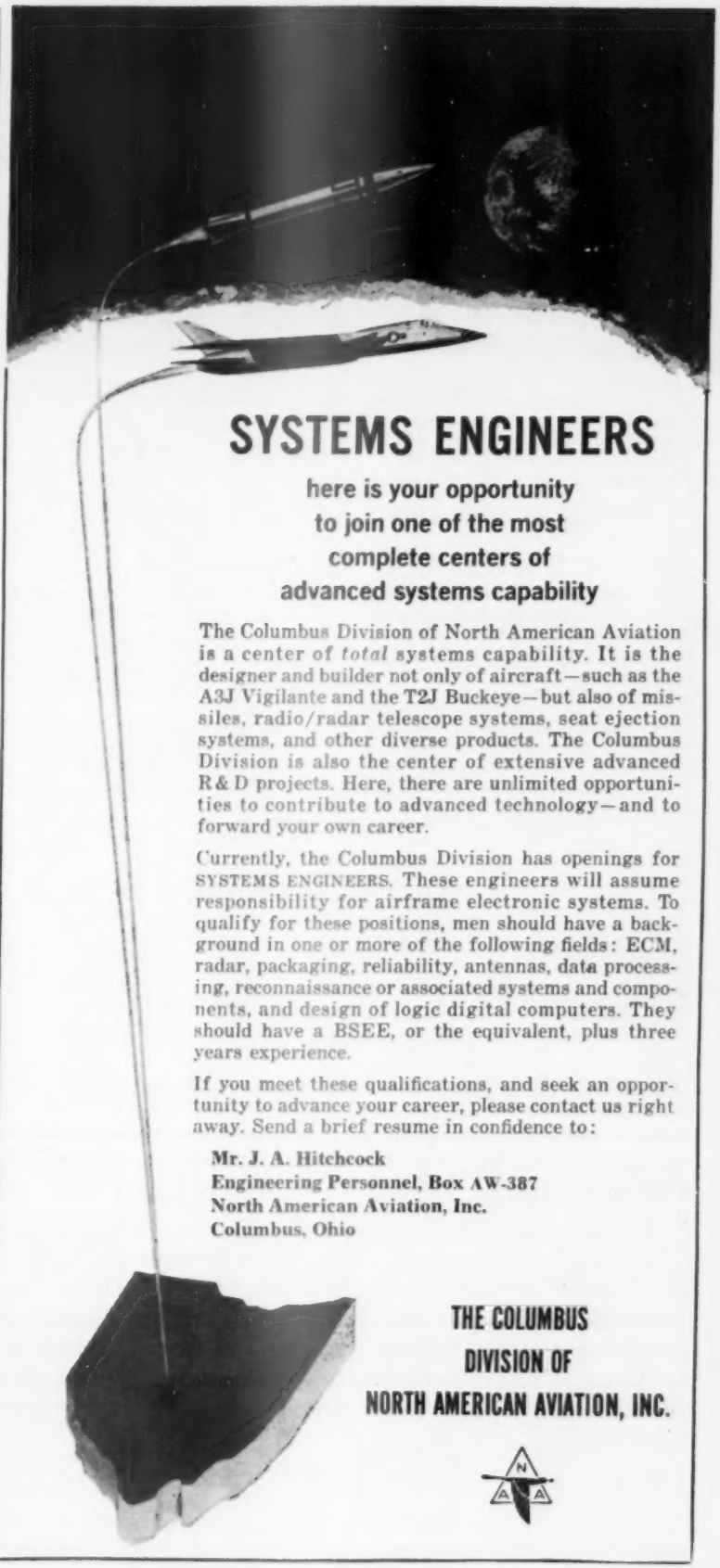
Aerodrome Fire Service Standing Orders has, under the title "General Hints," a paragraph headed "Attending Disaster Calls in Fog" which states:

"On receiving a disaster call in fog, immediate contact must be made with ground controller for guidance to the scene of disaster with the aid of Airfield Surface Movements Indicator—Radar (ASMI). Applicances will then proceed in convoy formation with a R/T appliance leading other R/T appliances dispersed among the convoy and a R/T appliance in the rear. The officer in charge is to check at frequent intervals that all appliances are keeping station by contacting other mobile stations in the convoy." It is noted that these instructions are described as a guide and are not to be rigidly adhered to and that circumstances will govern subsequent action.

Although no definition of fog is given and visibility is not included in the ATC disaster message to AFS, the station fire officer knew from his own observations that the visibility was not good, therefore it would have been prudent for him to have requested guidance by ASMI. Tests carried out subsequently in one of the large appliances showed that from a standing start inside the fire station it took 70 sec. to reach the scene of the accident or 100 sec. if the speed was limited to 20 mph. From these figures it is believed that the vehicles could have reached the aircraft under ASMI guidance in not more than three minutes instead of the eight and a half minutes which the first to arrive actually took. In addition, they would all have arrived together and the officer in charge would have been there to coordinate their efforts.

The lighting controller in the tower switched on green taxiway lighting that would have led the fire appliances from the station to the aircraft but unfortunately the vehicles turned away from the lights. When it was seen on the ASMI screen that they were going in the opposite direction the taxiway lighting was reselected to guide them but the drivers did not know that the lights had been put on for their benefit. No predetermined system for such use of the taxiway lights had been drawn up between AFS and ATC.

Exercises in the use of ASMI for guiding the fire service in low visibilities had been carried out from time to time since the initial trials late in 1955. It was concluded that ASMI had proved successful but that the method of communication used, i.e., ATC to AFS watchroom by telephone, AFS watchroom to appliances by R/T, was not very satisfactory because of the time lag and the possibility of human error. Suggestions were therefore made to enable ATC to communicate directly with appliances. Attention was also drawn to the fact that the Middlesex County Council Fire Service was not on the AFS frequency



SYSTEMS ENGINEERS

here is your opportunity to join one of the most complete centers of advanced systems capability

The Columbus Division of North American Aviation is a center of *total* systems capability. It is the designer and builder not only of aircraft—such as the A3J Vigilante and the T2J Buckeye—but also of missiles, radio/radar telescope systems, seat ejection systems, and other diverse products. The Columbus Division is also the center of extensive advanced R & D projects. Here, there are unlimited opportunities to contribute to advanced technology—and to forward your own career.

Currently, the Columbus Division has openings for SYSTEMS ENGINEERS. These engineers will assume responsibility for airframe electronic systems. To qualify for these positions, men should have a background in one or more of the following fields: ECM, radar, packaging, reliability, antennas, data processing, reconnaissance or associated systems and components, and design of logic digital computers. They should have a BSEE, or the equivalent, plus three years experience.

If you meet these qualifications, and seek an opportunity to advance your career, please contact us right away. Send a brief resume in confidence to:

Mr. J. A. Hitchcock
Engineering Personnel, Box AW-387
North American Aviation, Inc.
Columbus, Ohio

THE COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC.

and so could not be guided by ASMI. These suggestions by the airport authorities were not acted upon but were brought up again three years later and further trials were made during the last fortnight of 1958.

Following further consideration approval was sought in July, 1959, for equipment with which to make the AFS channel available to the GMC and a week after the accident the AFS frequency was introduced at the GMC position in the tower as a temporary measure pending installation of improved facilities. Similar steps were taken so that certain Ministry Constabulary vehicles could also communicate direct with GMC.

Conclusions

The aircraft had valid certificates of airworthiness and maintenance and had been maintained in accordance with an approved maintenance schedule.

The pilots were properly licensed.

There was no evidence of any pre-crash defect.

The nosewheel unit attachments were fractured upon first impact with the runway because the nosewheels contacted the ground before the main wheels.

The captain had insufficient visual reference by which to judge the flareout because of the unexpected and critical reduction in visibility.

The reduction of RVR from 400 yd. to 250 yd. at 1920 hr. was not passed to the aircraft because of a human failure in air traffic control, the exact source of which could not be determined in view of conflicting evidence. Had it been passed to the aircraft, the captain would have had no option but to discontinue his approach.

The further reduction of RVR to 100 yd. at 1922 hr. was withheld by the No. 1 Director on his own initiative. However, in all the circumstances, it cannot be said with any degree of certainty that this omission had a direct bearing on the cause of the accident.

Opinion

The accident was caused by the failure of air traffic control to notify the captain of a critical deterioration in runway visual range during his final approach. In consequence he attempted to land in a visibility which gave him insufficient visual reference with the result that the nosewheels contacted the runway before the mainwheels, thereby overstressing the nosewheel unit and fracturing its attachments.

On July 5, 1960, a letter was sent to the Director-General of Navigational Services, Ministry of Aviation, giving notice that responsibility for the accident was being attributed to air traffic control at London Airport. The letter offered those who might have been concerned an opportunity of exercising their rights under regulations and indicated the facilities that would be available to them for that purpose.

On July 29, 1960, the Director-General of Navigational Services replied that none of the officers wished to avail themselves of the rights open to him under the appropriate regulation.

J. W. Duggan, Deputy Chief Inspector of Accidents, Accidents Investigation Branch, Ministry of Aviation.

The following action was taken shortly after the occurrence of the accident:

- **To guard against** the possibility of a reported fall in visibility not being passed to an aircraft making an approach with "radar talk-down" assistance: a direct telephone link has been provided between the observer, who measures runway visual range, and the approach controller; this replaces the previous practice of passing information through the air controller; indicators have been installed at the "talk-down" controllers stations, which eliminate the need for changes in Runway Visual Range to be passed verbally.
- **To relieve the "talk-down"** controller of the responsibility for deciding whether to interrupt a "talk-down" sequence to pass changes in runway visual range: instructions have been issued requiring him to pass without delay any significant changes notified to him while the aircraft is on the final stage of the approach.
- **To reduce the chances** of rescue vehicles and fire appliances being delayed by fog in moving to the scene of an accident: a direct radio telephone link has been provided between the Ministry of Aviation vehicles and the air traffic control tower. This enables radar directions to be passed direct to the vehicle drivers instead of via the fire service watch room.
- **To enable firemen** to find the hydrants quickly: in addition to the marking of hydrant positions, markings are being provided at the runway edges opposite these positions and a line leading between the runway edge and the hydrant position is being marked on the ground. ◆◆

work in Southern California on the

EAGLE

ADVANCED OPPORTUNITIES FOR SENIOR ENGINEERS

Bendix-Pacific Division, North Hollywood, California, as a member of the Bendix Corporation "EAGLE" Development Team, is a major contributor to the Navy's newest air-to-air Missile "EAGLE." This weapon system is a second generation air-to-air Fleet Defense System and offers challenging design opportunities to the creative engineer.

ADVANCED POSITIONS ARE OPEN TO MEN WITH BACHELOR, MASTER AND DOCTOR DEGREES IN ELECTRICAL AND MECHANICAL ENGINEERING WITH EXPERIENCE IN: ELECTRONIC CIRCUIT DESIGN AND MECHANICAL PACKAGING. OTHER HIGH-LEVEL ELECTRONIC ENGINEERING POSITIONS AVAILABLE

Please send resume to
W. C. WALKER,
ENGINEERING EMPLOYMENT MANAGER

Bendix-Pacific Division
11606 SHERMAN WAY
NORTH HOLLYWOOD, CALIFORNIA

THE Bendix CORPORATION

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant | **Civil Service Opportunities** | **Employment Agencies**
Positions Wanted | **Selling Opportunities Wanted** | **Employment Services**
Part Time Work | **Selling Opportunities Offered** | **Labor Bureaus**

DISPLAYED —RATES— **UNDISPLAYED**

The advertising rate is $52.00 per inch for all advertising appearing on other than a contract basis. Frequency rates quoted on request.

An Advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.
Position Wanted Ads are ½ of above rate.
Box Numbers—counts as 1 line.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.
Not subject to Agency Commission.

Send NEW ADS to Classified Advertising Div. of AVIATION WEEK, P. O. Box 12, N. Y. 36, N. Y.

High level openings for Development Engineers needed for work on advanced aircraft, missile and space vehicle applications.

FLUTTER and VIBRATION SPECIALIST
Degree in Engineering, Physics, or Applied Mechanics with minimum of 5 years experience in aeroelasticity, vibration or flutter. Should have strong theoretical background in unsteady aerodynamics, structural response and applied mathematics or practical experience in dynamics model design and testing, aircraft vibration and flight flutter testing.

DYNAMICS SPECIALIST
Degree in Engineering, Physics, or Applied Mechanics with experience in vibration, transient dynamics problems, structural analysis, analog or digital simulation methods.

THERMODYNAMIC and/or AERODYNAMIC HEATING SPECIALIST
BS or MS in Engineering with 7 to 10 years experience in thermodynamic heat transfer and/or aerodynamic heating. Propulsion experience and rocket background desirable.

For confidential consideration send resume to:

H. L. GORDON
Professional Employment Manager
LOCKHEED AIRCRAFT CORPORATION
834 West Peachtree St. N. W.,
Atlanta 8, Georgia
LOCKHEED Georgia Division

Commission Sales Representatives—Aviation Chemical Field—Representation needed for all areas at once—

Should have following or contacts with Airlines, Air Frame Manufacturers and Government bases local purchases. Please send resume to

RW-5451, Aviation Week
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

SELLING OPPORTUNITY AVAILABLE

Prominent manufacturer with world-wide reputation for advanced design mechanical and electro-mechanical aerospace equipment is establishing nationwide representation. Areas of particular interest at this time are: New England either all or part; Metropolitan New York, Long Island, New Jersey; Ohio and Michigan; Illinois, Wisconsin, Minnesota; Southeast—Atlanta area and Alabama; Florida; Denver; West Coast. Technical background required. If interested please advise Territory, present Accounts represented, approximate annual volume, firm history and individual backgrounds. Appointments will be arranged. RW-5460, Aviation Week.

POSITIONS WANTED

A&P licensed mechanic twelve years with commercial pilot license. 200 hours SEL. Desire pilot-mechanic position foreign or domestic. PW-5444, Aviation Week.

Desire change—11 years aviation maintenance experience on large corp. aircraft. A&E and I.A. ratings. 28 years old. Will consider all offers. PW-5454, Aviation Week.

Engineers, EE

The Closest Thing to Running Your Own Business

FIELD ENGINEERING at the Light Military Electronics Dept. of General Electric

To some engineers, being on their own professionally is an all-important factor. Are you one of these individualists who is at his best when working on his own?

The LME Dept. Field Engineer is G.E.'s sole representative at many of the locations and it is his responsibility to give expert professional assistance.

Assignments may be in any of the 50 states. Average is one year at one location.

You will be trained at one of our plant locations in one or more of the following product lines:

Radar/Countermeasures/
Digital Communications/
Navigation/Armament Systems/
Flight Control/Missile Guidance/
Test Equipment

Requirements: BS in Electrical Engineering or BS in Mechanical Engineering, Physics or Mathematics with minimum of 2 years electronics experience.

Write today—and by return mail
we'll send a simple application form. Mr. Vernon Wild, Room 64-WO

LIGHT MILITARY ELECTRONICS DEPT.—PRODUCT SERVICE

GENERAL ELECTRIC

831 Broad Street, Utica, N. Y.

FOR INFORMATION

About Classified Advertising,

CONTACT

The McGraw-Hill Office Nearest You.

ATLANTA, 3—1301 Rhodes-Haverty Bldg.
R. POWELL JAckson 3-6951

BOSTON, 16—Copley Square
M. J. HOSMER COngress 2-1160

CHICAGO, 11—520 No. Michigan Ave.
W. J. HIGGENS MOhawk 4-5800

CLEVELAND, 13—1164 Illuminating Bldg.
W. B. SULLIVAN SUperior 1-7000

DALLAS, 2—1712 Commerce St., Vaughn Bldg.
J. GRANT Riverside 7-5117

DENVER, 2—1700 Broadway—Tower Bldg.
J. PATTEN ALpine 5-2981

DETROIT, 26—856 Penobscot Bldg.
P. HAMMOND WOodward 2-1793

HOUSTON, 25—Prudential Bldg., Holcombe Blvd., Rm. W-724
GENE HOLLAND JAckson 6-1281

LOS ANGELES, 17—1125 W. 6th St.
W. C. GRIES HUntley 2-5450

NEW YORK, 36—500 Fifth Ave.
H. T. BUCHANAN - R. P. LAWLESS
T. W. BENDER OXford 5-5959

PHILADELPHIA, 3—Six Penn Center Plaza
H. W. BOZARTH LOcust 8-4330

PITTSBURGH, 22—4 Gateway Center
P. PIERCE EXpress 1-1314

ST. LOUIS, 8—3615 Olive St. JEfferson 5-4867

SAN FRANCISCO, 4—68 Post St.
S. HUBBARD DOuglas 2-4600

For Engineers:

Exceptional career openings in Boeing's new

ANTENNA DEPARTMENT

The creation of a specialized Antenna Department now brings the full scope of Boeing's research and engineering facilities and resources to focus on the custom design and manufacture of all types of surface and airborne antenna systems.

For qualified engineers, it means an exceptional opportunity to grow with this important new department. There are a number of openings in these four areas:

STRUCTURAL DESIGN
MECHANICAL ENGINEERING
SERVOMECHANISMS
ELECTROMAGNETIC APPLICATIONS

You will need at least a BS degree in any engineering discipline, with applicable experience preferable. Salaries are open and competitively commensurate with your experience. Boeing provides liberal transportation and moving allowances.

At Boeing you'll enjoy the advantages of living in the uncongested, evergreen Pacific Northwest, famous for mild year-round climate, fine schools and housing and unexcelled recreational facilities for the whole family.

Write today to: Mr. W. B. Evans, Boeing Airplane Company, P. O. Box 3707 - AVX, Seattle 24, Wn.

BOEING

ADVANCE RESEARCH AND DEVELOPMENT POSITIONS

LIQUID PROPELLANTS ENGINEER—B.S. Chemistry or Chemical Engineering, 2-5 years experience working with storable liquid rocket propellants. Responsible for establishing handling techniques and safety measures. Capable of performing analytical chemical control on propellants and establishing compatibility of materials of construction in utilization of propellants.

BEARINGS AND SEALS ENGINEER—M.S. desirable, B.S. mandatory, M.E. preferred practical experience is a necessity. Capable of heading up a program aimed at designing and developing dynamic seals and fluid film bearings, also static and dynamic seals to be incorporated in hydraulic pumps, motors and valves. The program will include advanced designs for future applications involving high temperatures, high-speeds and low lubricity fluids.

DESIGN ENGINEER (hydraulics)—Engineering degree, experienced designer to perform design calculations and layout of hydraulic pumps, motors, valves and hot gas components. Must have the ability to originate new design concepts. Familiarity with aircraft and missile design requirements desirable. Position requires knowledge of fluid mechanics, stress analysis, materials selection and fabrication techniques. Please send resume to Mr. R. E. Barlow.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORP
Administrative & Engineering Center
P.O. Box 302 Detroit 32, Michigan

IN ALL INTERESTS OF AVIATION

If You're important, you either read **AVIATION WEEK**

or you advertise in it, or both

"Put Yourself in the Other Fellow's Place"

TO EMPLOYERS
TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

MR. EMPLOYEE you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section.

We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division

McGRAW-HILL PUBLISHING CO., INC.
330 West 42nd St., New York 36, N. Y.

ENGINEERS . . .

AT VERTOL

CREATIVITY FLOURISHES

The advantages of working at Vertol are being discovered by increasing numbers of engineers. The reasons are apparent. The Vertol Division off Boeing is small enough for the engineer to retain his individuality and freely exercise his creativity. In addition, the Vertol engineer has all the resources of one of the nation's leading companies behind him.

Long a leader in the design and production of advanced commercial and military vertical lift aircraft, Vertol is now expanding its international and domestic activities. As a result, new and challenging career opportunities are available to ambitious, creative engineers. Located in attractive suburban Philadelphia, Vertol provides an environment of growth for qualified engineers. Investigate these opportunities today:

INSTRUMENTATION

FLIGHT TEST . . . The man who fills this responsible position should have the ability to design, develop, calibrate and install flight test instrumentation. Experience in magnetic tape and telemetering desirable.

STRUCTURAL TEST . . . An outstanding position requiring experience in instrumentation for wind tunnel testing or associated fields.

AERODYNAMICS

Challenging position entailing aerodynamic studies in performance or flying qualities and dynamic stability of VTOL/STOL aircraft. Low-speed stability and control performance plus wind tunnel or flight test experience are required.

STRESS

Outstanding position requiring airframe experience in the determination of applied loads and the performance of stress analysis to insure structural integrity.

ACOUSTICS

This career position requires experience in the field of noise reduction. Varied duties include measurement of data through design of acoustical treatments for aircraft, and the operation of noise reduction research programs.

Each of these positions requires an appropriate academic degree plus directly related experience, and offers an attractive salary. Forward your resume in complete confidence to:

Duane O. Olsen
Supervisor of Personnel Relations

VERTOL DIVISION
NORTON PENNSYLVANIA BOEING

ENGINEERS

"QUALITY CONTROL"

THESE ARE GLAMOUR WORDS AT GENERAL ELECTRIC'S ORDNANCE DEPARTMENT

"Research," "Design," "System Engineering"—these are glamour words in today's technological thesaurus. Mention QC and it conjures up the image of dull, day-in, day-out routine. Valid as this may be when applied to many organizations, it misses the mark by three country miles when applied to QC activity at the Ordnance Department.

We encourage invention, innovation and improvisation from Quality Control Engineers. The reason is simple. The ultra-precision demanded in the manufacture of our products—the Polaris fire control and guidance systems, for example—requires imaginative QC approaches, not just the refinement of tired old techniques.

Day-in, day-out routine? Not at Ordnance Department! Our QC Group employs a totally integrated quality control program. That means an engineer can participate in all of these areas:

• ***Preproduction quality definition and evaluation*** • ***Purchased material quality planning, evaluation and control*** • ***Development of quality information equipment*** • ***Product and process quality evaluation and control*** • ***Special quality studies*** • ***Quality training, orientation and manpower development*** • ***Quality control management*** • ***Product and process quality planning*** • ***Quality information feedback*** • ***Past production evaluation.***

One more thing. There's plenty of room to move up the ladder at Ordnance. The reason for this ad is to fill spots made vacant by some of our people who were promoted last month.

If you possess a degree in engineering and from 3 to 12 years QC experience, and want to express your imagination and enthusiasm, we invite you to investigate our immediate openings. Please forward your inquiries, including salary requirements to: W. B. Walker, Rm. 64-WP

ORDNANCE DEPARTMENT
OF THE DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

800 PLASTICS AVENUE, PITTSFIELD, MASSACHUSETTS

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

DISPLAYED RATE:

The advertising rate is $31.00 per inch for all advertising appearing on other than on contract basis. Contract rates on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE:

$2.70 a line, minimum 3 lines. To figure advance payment count 8 average words as a line.

PROPOSALS, $2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

Send NEW Ads or Inquiries to Classified Adv. Div. of Aviation Week, P. O. Box 12, N. Y. 36, N. Y.

FOR SALE

SPARE PARTS INVENTORY

for

C-46, DC-4, DC-6, 1049H Constellation Aircraft

also

WRIGHT COMPOUND 3350-EA-3 Engines

PRATT & WHITNEY R2800 CB16/17 Engines

THE FLYING TIGER LINE INC.

BURBANK, CALIF.

Call or Cable, Doug Duly

Tel.: TRiangle 7-3411 Cable: Flytiger

FOR SALE

C-46F AIRCRAFT

Passenger and Cargo
With or Without
T-Category Kit Installed

Immediate Delivery

THE FLYING TIGER LINE INC.

Burbank, Calif.

Call or Cable
FRED BENNINGER
Executive Vice President

Tel: TRiangle 7-3411 Cable: Flytiger

FOR SALE OR LEASE MARTIN 202

44 passenger airline interior, reversible props, heavy landing gear, airline radio
Airframe—192 hours since progressive overhaul
Low Time Engines—Available Immediately
Will ferry at cost anywhere. Price $125,000 with spare NT8O demountable power plant
"Will also consider a light twin in trade"
CHARLOTTE AIRCRAFT CORPORATION
P. O. Box 9127 Charlotte, N. C.

For sale or lease
Newly overhauled
C46F
Low time
C46As
Call/write for information
AAXICO
Box 48-875, Miami 48, Fla., (TU 7-1541)

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

FOR SALE

PBY, 5A. Tow amphibian converted for 2 crew—cargo—passenger use. FS-3404, Aviation Week.

Exceptional Executive 1956 E18S

Low Time Engines
Excellent Electronics
Available Immediately

CALL Digby 9-3140 (NYC)
Linden Flight Service, Inc., Linden, N. J.

EXECUTIVE DC-3

RADAR—A-12 AUTOPILOT
1830-94 Engines—*Excellent Condition*
FOR SALE OR LEASE—*Will trade*
WILLIAM C. WOLD ASSOCIATES
551 FIFTH AVENUE, NEW YORK 17, NY
Tel: Murray Hill 7-2050 Cable: Billwold New York

CONVAIRS
Airline and Executive
Several of Both Available

Convair Trade-In
DOUGLAS DC-3
200 M.P.H. A12 Autopilot
Trades Accepted

DOUGLAS DC-6
DC-6A DC-6B
Finance or Lease

Also Grumman Twin Beech and Lockheeds in Stock

Contact:
Frederick B. Ayer & Associates, Inc.
250 Park Avenue, New York 17, New York

WHERE TO BUY

Featuring additional products, specialties & services for the aviation field

---

FASTENERS FOR AIRCRAFT AND MISSILES
Immediate Delivery—AN—N.A.S.—M.S.—6 Digit
CERTIFIED TO GOVERNMENT SPECIFICATIONS
Bolts—Nuts—Rivets—Screws—Studs—Internal and External Wrenching Bolts—Dowel and Lock Pins

Mercury air parts co., inc.
9310 West Jefferson Blvd., Culver City, Calif.
Telephone—UPton 0-5923—Teletype—CVN CY 4138
TOUGH SPECIALS 10 DAY DELIVERY
MANUFACTURERS OF PRECISION HARDWARE

FOR SALE
LEASE OR LEASE PURCHASE
Boeing Model 377

STRATO CRUISER

14 AIRCRAFT
FROM
$75,000.00
Flyaway

U. S. Certificated 112 seat configuration, full overseas equipped. Long range. 20 NT8O engines. Large inventory of Supporting Aircraft and Engine Spare Parts.

WILLIAM STEINER
Phone: TOpaz 2-9355 or GArfield 6-4481
13010 Ardis Ave. Downey, California

LEGAL NOTICE

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 Stat. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION

Of Aviation Week and Space Technology, published weekly at Albany, New York for October 1, 1960.

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Published by McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 36, N. Y.; Editor, Robert B. Hotz, 330 West 42nd St., New York 36, N. Y.; Managing editor, William H. Gregory, 330 West 42nd St., New York 36, N. Y.; Business manager, John G. Johnson, 330 West 42nd St., New York 36, N. Y.

2. The owner is McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 36, N. Y. Stockholders holding 1% or more of stock are: Donald C. McGraw & Willard T. Chevalier, Trustees under Indenture of Trust m/b James H. McGraw, dated 1/14/21 as modified; Donald C. McGraw & Harold W. McGraw, Trustees under an Indenture of Trust m/b James H. McGraw, dated 7/1/37 as amended; Donald C. McGraw, individually; Estate of Mildred W. McGraw, Donald C. McGraw and Catharine McGraw Bock, Executors; (all of 330 West 42nd Street, New York 36, N. Y.); Grace W. Mebus, 536 Arenas St., LaJolla, Calif.; Affiliated Fund, Inc., 63 Wall St., New York, N. Y.; Geneva & Co., P. O. Box 491, Church St. Station, New York, N. Y.; Touchstone & Co., c/o Wellington Fund, Inc., Claymont, Delaware.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: 78,140.

McGRAW-HILL PUBLISHING COMPANY, INC.
By JOHN J. COOKE, Secretary.

Sworn to and subscribed before me this 15th day of September, 1960.

[SEAL] JANET A. HARTWICK.
(My commission expires March 30, 1961)

When You Need Quick Action

on Opportunities available or wanted in Aviation Week . . . USE

The Searchlight Section

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, OCTOBER 17, 1960

AIRBORNE ACCESSORIES CORPORATION..... 75
AIRCRAFT FITTING COMPANY, THE..... 93
AMP INCORPORATED 56
AMERICAN AIRLINES, INC. 53
AMERICAN OPTICAL COMPANY 13
ARCTURUS MANUFACTURING COMPANY 116
AVDEL, INC. 137
AVIATION WEEK AND SPACE TECHNOLOGY 152-153

BAUSCH & LOMB INCORPORATED, MILITARY PRODUCTS DIV. 67
BEECH AIRCRAFT CORPORATION 15
BENDIX ECLIPSE-PIONEER DIVISION, THE BENDIX CORPORATION 138-139
BENDIX PACIFIC DIVISION, THE BENDIX CORPORATION 160
BENDIX SCINTILLA DIVISION, BENDIX THE CORPORATION 123
BENDIX SYSTEMS DIVISION, THE BENDIX CORPORATION 86
BOEING AIRPLANE COMPANY 146
BUCKEYE IRON & BRASS COMPANY 126

CAMERON IRON WORKS, INC. 44
CANNON ELECTRIC COMPANY 124-125
CESSNA AIRCRAFT COMPANY 135
CHANCE VOUGHT AIRCRAFT, INCORPORATED 156
CHERRY RIVET DIVISION OF TOWNSEND COMPANY 111
COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC. 159
CONSOLIDATED DIESEL ELECTRIC CORP., AIRCRAFT EQUIPMENT DIV. 69
CONTINENTAL-DIAMOND FIBRE CORP., A SUBSIDIARY OF THE BUDD COMPANY 134
CRAIG SYSTEMS, INC. 110

DEL MAR ENGINEERING LABORATORIES 130
DELAVAN MANUFACTURING COMPANY 73
DEUTSCH COMPANY, THE 136
DONNER SCIENTIFIC CO., A SUBSIDIARY OF SYSTRON DONNER CORP. 104
DOUGLAS AIRCRAFT COMPANY, INC. 74
DOW CORNING CORP., SILICONES 4

EASTERN INDUSTRIES INC. 94
ELASTIC STOP NUT CORPORATION ..... 4th Cover
ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA 85, 110

FIBERITE CORPORATION 83
FOOD MACHINERY & CHEMICAL CORP., ORDNANCE DIV. 58-59
ROBERTSHAW-FULTON CONTROLS, FULTON SYPHLON DIV. 119

GARLOCK, INC. 14
GARRETT CORPORATION, THE 16, 61
GENERAL ELECTRIC COMPANY 144-145
GILFILLAN BROTHERS, INC. 108
THE B. F. GOODRICH COMPANY, AVIATION PRODUCTS 20
GRAND CENTRAL ROCKET COMPANY 98
GROVE VALVE & REGULATOR COMPANY 103

HARRISON RADIATOR DIVISION OF GENERAL MOTORS CORP. 11
HARTWELL CORPORATION, THE 127
HAYDON COMPANY, A. W. 72
HAYNES STELLITE COMPANY, DIV. UNION CARBIDE CORPORATION 24
HOFFMAN ELECTRONICS CORPORATION, MILITARY PRODUCTS DIV. 68

INTERNATIONAL AIR SERVICE COMPANY, LTD. 49
INTERNATIONAL TELEPHONE & TELEGRAPH CORPORATION 6

KAISER ALUMINUM & CHEMICAL CORP. 90-91
KAMAN AIRCRAFT CORPORATION, THE 35
KEARFOTT DIVISION, GENERAL PRECISION, INC. 93, 95, 97, 99
KELSEY HAYES COMPANY 17
KIDDE & CO., INC., WALTER 22

LAMTEX INDUSTRIES, INC. 7
LAVELLE AIRCRAFT CORPORATION 5
LEACH CORPORATION 36-37
LIQUIDOMETER CORPORATION, THE 10
LITTON INDUSTRIES, INC. 97
LOS ANGELES DIVISION OF NORTH AMERICAN AVIATION, INC. 147, 157

MAGNAFLUX CORP. A SUBSIDIARY OF GENERAL MILLS 120
MAGNETIC CONTROLS COMPANY 57
MARQUARDT CORPORATION, THE ..... 2nd Cover
MARTIN COMPANY, THE DENVER DIVISION 133
McGRAW-HILL COMPANY 109
METALS AND CONTROLS DIV., TEXAS INSTRUMENTS INCORPORATED 60
MICRO SWITCH DIV., MINNEAPOLIS-HONEYWELL REGULATOR CO. 114-115
MINNEAPOLIS HONEYWELL REGULATOR COMPANY 8-9, 155, 158
MINNEAPOLIS HONEYWELL REGULATOR CO., BOSTON DIV. 88
MOBIL OIL COMPANY 140
MOTOROLA, INC., MILITARY ELECTRONICS DIV. 76-77

NORD AVIATION 109

PHILCO CORP., GOVERNMENT & INDUSTRIAL DIV. 18
PRATT & WHITNEY AIRCRAFT DIV., UNITED AIRCRAFT CORP. 50
PRECISION PRODUCTS DEPT., NORTRONICS DIV. NORTHROP CORP. 82
PUROLATOR PRODUCTS, INC. 46

R. C. A. INDUSTRIAL ELECTRONIC PRODUCTS 64-65
RAYBESTOS-MANHATTAN, PLASTIC PRODUCTS DIV. 89
REEVES SOUNDCRAFT CORPORATION 142
RESISTOFLEX CORPORATION ..... 3rd Cover
ROCKETDYNE DIVISION OF NORTH AMERICAN AVIATION, INC. 80-81
ROHR AIRCRAFT CORPORATION 118
RUSKA INSTRUMENTS CORPORATION 127
RYAN AERONAUTICAL COMPANY 128

SAWYER COMPANY, INC., A. J. 143
SINCLAIR REFINING COMPANY 106
SINGER MANUFACTURING CO., THE—MILITARY PRODUCTS DIV. 112
SPACE ELECTRONICS CORP., A DIV. OF AEROJET-GENERAL CORP. 96
SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRON TUBE DIVISION 51

TEXAS INSTRUMENTS INCORPORATED 62
THIOKOL CHEMICAL CORPORATION, COMPONENTS DIVISION 66
THOMPSON RAMO WOOLDRIDGE INC., TAPCO GROUP 143
TITANIUM METALS CORPORATION OF AMERICA 84-85
TRANS WORLD AIRLINES, INC. 48

VICKERS, INC., DIVISION OF THE SPERRY RAND CORP. 3

WESTERN GEAR CORP., PRECISION PRODUCTS DIV. 12

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

WHERE TO BUY
Mercury Air Parts Co., Inc. 164
EMPLOYMENT OPPORTUNITIES 161-163
NOTICES
Legal 164
EQUIPMENT
(Used or Surplus New)
For Sale 164

ADVERTISERS INDEX

AAXICO Airlines 164
Ayer & Associates Inc., Frederick B. 164
Boeing Airplane Co. 162
Charlotte Aircraft Corp. 164
Flying Tiger Line Inc., The 164
General Electric 161, 163
Linden Flight Service Inc. 164
Lockheed Aircraft Corp 161
Steiner William 164
Vertol, a Division of Boeing 163
Vickers Inc., Div. of Sperry Rand Corp. 162
Weld Assoc., William C. 164

LETTERS

Denmark Editorial

I would certainly be derelict if I weren't to express our appreciation and gratitude for the outstanding editorial in your issue of AVIATION WEEK for Sept. 26. A lot of hard work has gone into not only depicting Copenhagen in its proper light as a gateway of fun and interest to Europe, but also to back it in terms of the service facilities, which you quite specifically point out, are of pre-emptive importance to the traveling public. Once again—thanks.

WARREN E. KRAEMER
First Vice President
Scandinavian Airlines System, Inc.
Jamaica, N. Y.

Your "Welcome to Denmark" editorial (AW Sept. 26) certainly rang a bell in this corner, especially the section headed "Pleasant Contrast." I recall with genuine pleasure the Imperial Hotel bar where Bill the bartender and his waiters made you feel they enjoyed serving you and that you were doing them a favor by showing up—rather than vice-versa.

FRANK J. DELEAR
Sikorsky Aircraft
Division of United Aircraft Corp.
Stratford, Conn.

It's a coincidence that what was in my mind has been expressed by you, in your current editorial (AW Sept. 26), in sentiments much more eloquently than I possibly could have done. From the I. A. F. session in Stockholm through Europe to the Olympics gave me a comprehensive picture of varying hospitalities, but nothing could possibly equal the friendly atmosphere of Copenhagen.

Well done.

LESLIE G. TAYLOR
Executive Vice President
Technical Industrial Consultants, Inc.
Washington, D. C.

I was very much interested in your editorial in Aviation Week, Sept. 26, and, like you, wax lyrical about Denmark and Copenhagen.

This summer I joined a 32-day coach tour and spent five days in Copenhagen and 10 days altogether in Denmark. I shall never forget the interest and courtesy of the Danish people, the food, particularly the confectionery, and the wonderful Tivoli Gardens. The only thing which was not what it should have been was the SAS service. The SAS planes are like the proverbial Russian railways; they go eventually, quite often several hours late, and by that time one has lost an important connection; i.e. I was delayed 24 hr. in getting back to Boston because of SAS. I am not alone in this criticism of SAS. When I do return to Scandinavia I shall fly BEA.

Thank you again for an excellent article.

GWENDOLINE M. JACKSON
Cambridge, Mass.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Powers Award

In your Oct. 3 Aviation Week (p. 126), John Zawiski suggests the creation of a Francis G. Powers Award to individuals or groups making significant contributions to aerial reconnaissance. I'm not saying I'd have done any differently than Powers if I'd been captured by the Russians. But I hope I would have. One thing is certain in my mind, I wouldn't want anybody to preserve the memory of my performance by an award. I would want to forget it, and I would want my fellow countrymen to forget it.

FRANK HARVEY
Drakestown Road
Hackettstown, N. J.

U-2 Mission

Re: U-2 Pilot Award, AW Oct. 3 (p. 126). Mr. John Zawiski's letter proposing a Francis G. Powers Award, I believe, is completely out of order.

Mr. Zawiski states that he has never been connected with any aviation company or any aviation service. Due to his lack of contact with the aviation world he may not realize that when we pay large salaries we expect that the job will be done fully and properly. We, and I use this expression as a taxpayer, paid Mr. Powers $30,000 a year to do a job and we will be paying that salary for the next 10 years while he sits in a Soviet jail, with the job uncompleted.

A part of Mr. Powers' job was to destroy the aircraft and himself if captured or stopped on his mission. In failing to do his job properly and fully he has caused the United States world-wide embarrassment, and discovery of a very valuable aircraft.

If the job had been a normal one it would have been flown by a captain or lieutenant of the United States Air Force at his normal pay rate.

Mr. Powers knew what he was getting into when he took the job and his salary was commensurate with the risk involved.

To Mr. Zawiski's question—I say no, I would not fly over Russia for twice the salary as I am a married man with three children to support, but there are many unmarried men who would take the job and accept the risk that goes with the high salary and they would complete the job if stopped in their mission.

I say that Francis G. Powers was no credit to the aircraft he flew.

CHARLES F. ROCHE
Fairfield, Conn.

Bell 204B Speed

May I call your attention to a rather obvious typographical error on p. 147 of the Sept. 12 issue of AVIATION WEEK. In the data on the Bell Model 204B performance, the most economical cruise speed at 6,000 ft. is listed as 216 mph.; this should be 116 mph. or about 100 kt. TAS.

I consider AVIATION WEEK an excellent magazine and enjoy reading it each week.

DAVID C. NORMAN
Dayton, Ohio

(Reader Norman is partially correct. Instead of 216 mph., most economical cruise speed (6,000 ft.) should have been 126 mph., which is the figure listed in the factory specifications. We do not know Mr. Norman's source for the 116 mph. figure. —Ed.)

Passenger Plight

Viva! Viva!

As head of the Brazilian Coffee Institute, and President of the Pan American Coffee Bureau, I have to do more flying now than maybe even in my Air Force days.

My well worn out nervous system found gratifying, if useless, consolation today reading your editorial about the "poor passenger" (AW Oct. 3, p. 21). You're right on all counts. One thing you forgot: being stranded in Abidjan for lack of seating, even though your ticket has an O.K.

By the way, did you ever try to present your ticket at Eastern's counter in Washington around five in the afternoon?

My best wishes to your magazine, to which I have been subscribing for years to keep abreast of my old love–flying.

J. R. S. HAFERS
Brazilian Coffee Institute
New York, N. Y.

Spares Cost

Re: Letter entitled "High Spares Cost" on p. 122 of the Aug. 22 issue of AVIATION WEEK:

This is a long overdue short story concerning costs of doing government business. Having been in this business for many years I can assure you that no statement is untrue. In fact, I am sure that many additional points could be made, as, e.g., in one recent case where one government agency wanted 20 of our standard units, specifications required that the nameplates (not the instruments, but the nameplates) had to be given an environmental test, the minimum charge for which would be at least $500 and resulting in considerable delay in shipment. This was for 20 off-the-shelf items!

Congratulations on bringing this story out.

A. W. PARKES, JR.
President
Ballantine Laboratories, Inc.
Boonton, N. J.

HOSE SHOP OPERATIONS AND EQUIPMENT
1—Simple hand shear cuts hose to desired length.
2—Socketing guide speeds installation.
3—Nipple inserting machine.
4—Elbow jig accurately aligns fittings.
5—Compact field swager compresses socket.
6—Pressure test bench checks out assembly.
7—Cleaning tank flushes assembly with solvent.

Now...the reliability and economy of swaged-fitting hose assemblies can be assured in any hose shop with the RESISTOFLEX Portable Swaging Tool!

Now it is possible to make "factory-quality" Fluoroflex®-T hose assemblies with swaged fittings in any hose shop. The simple, dependable field swaging tool developed by Resistoflex eliminates the need for stocking large inventories of hose assemblies, permits easier scheduling of overhaul and repair requirements with lines made-to-order. Expensive fittings can be salvaged—only the socket need be sacrificed—and the repaired assembly can be reused with complete assurance of full, specified performance.

More and more airline and commercial operations are investigating the advantages of Fluoroflex-T hose assemblies and the reliability and economies offered by the Resistoflex portable field tool. Because positive operating stops are built into the tool, always-correct assemblies are assured. It can be used with the same reliability as factory-assembled products.

Fluoroflex-T, the superior Teflon® hose, is non-aging, has unlimited shelf and service life. It qualifies for service at all temperatures from —65° to +450°F. The Resistoflex Swaged Fitting was first introduced with the original fluorocarbon hose in 1953. Its reputation for reliability stands unchallenged, with millions of assemblies in service and never a blowoff on record.

To assure trouble-free operations, specify Fluoroflex-T for original equipment, retrofit, and repair. Write for complete information today.

ORIGINATORS OF FLUOROCARBON HOSE ASSEMBLIES

RESISTOFLEX CORPORATION

COMPONENTS FOR HIGH-TEMPERATURE AND CORROSIVE SERVICES

Plants in Roseland, N. J. • Anaheim, Calif. • Dallas, Tex.
Sales Offices in major cities

®Fluoroflex is a Resistoflex trademark, reg. U. S. Pat. Off.
®Teflon is Du Pont's trademark for TFE fluorocarbon resins.

UNIVERSITY MICROFILM INC
STEVENS RICE OS H
313 N 1ST ST
ANN ARBOR MICH C

SPECIFY ELASTIC STOP® NUTS FOR ALL CRITICAL BOLTED CONNECTIONS

Elastic Stop nuts have long been considered the standard fastener for aircraft and missile assembly because of their consistent quality and dependable performance under conditions of severe vibration and shock. Since the performance of any weapon system is no greater than the total reliability of every component, the designers and manufacturers of G/S/E, whether airborne or land-based, are required to obtain the same degree of protection against fastener failure.

Only ESNA offers three locking devices and a tremendous inventory of standard types and sizes, giving the engineer complete design freedom to select the self-locking fastener that will precisely solve his problem. No amount of vibration caused by transportation over bumpy terrain will shake ESNA self-locking fasteners loose. In movement from plant to base, or from storage areas to ready sites, G/S/E assembled with ESNA fasteners at critical connections always stay in precise adjustment—ready to do their work under all conditions.

For a copy of Bulletin 6001 describing ESNA's three locking devices, applicable military approvals and visually reviewing the complete ESNA line, write Dept. S55-1025, Elastic Stop Nut Corporation, 2330 Vauxhall Road, Union, New Jersey.

NYLON INSERT TYPE — for temperatures up to 250° F. The smooth, non-galling plastic grip will not loosen under severest vibration; has capacity to absorb shock and impact loads. Its elastic recovery characteristic makes nylon re-usable through more than 50 on-off cycles.

OVAL OFFSET LOCKING TYPES—particularly suitable for lightweight, close-clearance applications up to 900° F. and 1200° F. High hardness in the nut provides a spring action in the offset crown of the nut which provides a consistent locking torque and excellent re-use characteristics.

SLOTTED BEAM — for high-performance applications up to 1200° F. The long tapered beams provide a precise degree of elastic containment of the entering bolt threads and, acting as spring members, assure tightness under vibration and re-useability. Recognized as the standard of the jet engine industry for heavy-duty, ultra high temperature performance.

ELASTIC STOP NUT CORPORATION OF AMERICA (ESNA®)